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ABSTRACT

The socializing role of computer-assisted instruction (CAI) was seen to be a positive one in this study. The students, predominantly Mexican-American, who experienced CAI, and other students, in a control group, who did not, liked the computer. They thought it gave the right answers and they respected it as having a vast array of information available to it. They also saw it as fair, trusted its evaluations as well as its handling of task assignments, and sometimes attributed to it an almost human role. Feelings of greater trust in the learning situation managed via computer as compared to a learning situation monitored by a teacher were especially evident among CAI students. On the other hand, while both groups tended to ascribe charismatic qualities to the computer rather than to the teacher, CAI students were more aware than their Non-CAI peers of the computer's unresponsiveness to students' eventual desires to change the course or the content of its lessons. Greater confidence in the computer as compared to the teacher may follow from the fact that the teacher is perceived as evaluating student performance in mathematics tasks on the basis of behavior not related to these tasks. (MF)

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Stanford Center for Research and Development in Teaching

SCHOOL OF EDUCATION STANFORD UNIVERSITY

STANFORD CENTER
FOR RESEARCH AND DEVELOPMENT
IN TEACHING

Technical Report No. 13

THE COMPUTER AS A SOCIALIZING AGENT: SOME SOCIOAFFECTIVE OUTCOMES OF CAI

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Introductory Statement

The central mission of the Stanford Center for Research and Development in Teaching is to contribute to the improvement of teaching in American schools. Given the urgency of the times, technological developments, and advances in knowledge from the behavioral sciences about teaching and learning, the Center works on the assumption that a fundamental reformulation of the future role of the teacher will take place. The Center's mission is to specify as clearly, and on as empirical a basis as possible, the direction of that reformulation, to help shape it, to fashion and validate programs for training and retraining teachers in accordance with it, and to develop and test materials and procedures for use in these new training programs.

The Center is at work in three interrelated problem areas: (a) Heuristic Teaching, which aims at promoting self-motivated and sustained inquiry in students, emphasizes affective as well as cognitive processes, and places a high premium upon the uniqueness of each pupil, teacher, and learning situation; (b) The Environment for Teaching, which aims at making schools more flexible so that pupils, teachers, and learning materials can be brought together in ways that take account of their many differences; and (c) Teaching the Disadvantaged, which aims to determine whether more heuristically oriented teachers and more open kinds of schools can and should be developed to improve the education of those currently labeled as the poor and the disadvantaged.

Technical Report No. 13, presented here, describes the results of a study of the socializing role of computer-assisted instruction. The study is the first in a series that will explore the uses and impact of the computer in the classroom, in its application to out-of-school experience, and in research. The subjects were junior high school students in the Bay Area. The students' more positive attitude toward the computer than toward the teacher is of special interest to the investigators because of its special implications for use of the computer in teaching disadvantaged children. The Impact of Technology project, under which the study was carried out, is part of the Center's program on Teaching the Disadvantaged.

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Abstract

This is the first in a series of studies of the socializing role of computer-assisted instruction. Its purposes are to clarify conceptual issues arising from application of socialization theory to interactions between humans and machines; to develop strategies for studying human orientations to computers; and to collect baseline data on parameters of children's attitudes toward computers as sources of information and instruction.

Data from unstructured interviews and observation of students taking CAI were used to develop a questionnaire and a semistructured interview schedule. Data for this study were collected from 189 junior high school students (grades 7, 8, 9), 50 of whom had been assigned by their teachers to CAI--an arithmetic drill-and-practice program administered as remedial instruction in mathematics. The research group was predominantly from Mexican-American, lower SES backgrounds. Responses were analyzed to allow comparisons between students with and without actual experience with CAI (CAI versus Non-CAI groups).

Both CAI and Non-CAI students had a very positive image of CAI and the computer--they liked it, thought that it gives right answers, and saw it as having a vast array of information available to it. They also saw it as fair, trusted its evaluations as well as its handling of task assignments, and sometimes attributed to it an almost human role.

Both groups perceived CAI and the computer in more positive terms than other sources of information and instruction. The major elements of the favorable image of the computer were associated with the idea of greater expertise in processing and transmitting information. Feelings of greater trust in the learning situation managed via computer as compared to that monitored by the teacher were especially evident among CAI students. On the other hand, while both groups tended to ascribe charismatic qualities to the computer rather than the teacher, CAI students were more aware than their Non-CAI peers of the computer's unresponsiveness to students' eventual desires to change the course or the content of its lessons.

Data from the CAI group provide indications that greater confidence in the computer as compared to the teacher may follow from the fact that the teacher is perceived as evaluating student performance in mathematics tasks on the basis of behavior not related to these tasks. The machine is seen as exercising primarily task-related functions and, thus, it does not bring with it the affective and evaluative components which are inevitably present in teacher-student interactions.

The findings have implications for the development of CAI and its uses in schools as well as for analyzing and evaluating the effectiveness of teacher behavior and teaching processes. The report should be of interest to institutions responsible for teacher preparation and teacher training, to research and development centers for CAI, and to those interested in conducting research in these areas.

THE COMPUTER AS A SOCIALIZING AGENT:

SOME SOCIOAFFECTIVE OUTCOMES OF CAI

Robert D. Hess and Maria D. Tenezakis[1]
with
Ian D. Smith, Rodney L. Brod, Judith B. Spellman,
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This is the first in a series of studies investigating the effects of computer-assisted instruction (CAI) upon children's attitudes and orientations toward computers as sources of information and instruction.

The basic assumption is that computers, as used in instructional programs, seem to acquire some of the properties of human socializing agents. The purposes of this first study were (a) to clarify some of the conceptual issues arising from application of socialization theory to interactions between humans and machines; (b) to develop strategies for studying human orientations to computers; and (c) to collect baseline data on the parameters of children's responses to CAI.

Theoretical and Conceptual Context

Education as Socialization

In technologically advanced societies, formal education has a dominant role in the socialization of the young. This is reflected in the

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U.S. in the growing proportion of time preadults spend in formal education and the expanding number of areas of behavior and attitudes covered by the explicit curriculum. Although it is customary to think of the outcome of education in terms of the achieving of explicit curricular goals, it is also useful to consider other, perhaps unintentional, consequences of educational experience. These outcomes, both designed and accidental, are of increasing importance as the total potential socializing power of the school increases in the society.

Outcomes of educational experience. For the purposes of this study, it is useful to group the outcomes of educational experience into three categories:

a. Acquisition of curricular content: In the process of education the child acquires concepts, facts, develops cognitive operations, and gains specific educational skills such as reading and mathematics.

b. Learning of information-processing strategies: The child also acquires techniques for obtaining, organizing, and presenting information in ways appropriate for (future) utilization.

c. Orientation toward the system: This includes acquisition of attitudes and expectations about the school as an institution; evaluations of teachers; reactions to the school's norms, and acceptance of the school's goals. It also implies attitudes and feelings about one's self and one's role as a pupil, including the need to attend to material assigned by the teacher, to complete tasks, to learn in groups.

The first two of these categories are generally regarded as primary educational objectives. The third may be thought of as a by-product of education--a stance toward the system inherent in the fact of participating in it, but transitory, and having little significance for subsequent adaptation in the society. Hence, monitoring children's attitudes and expectations about the system (and their corollary feelings about themselves) is less deliberately incorporated in educational objectives.

The investigators assume that attitudes toward the system are not unrelated to the students' future behavior either as scholars or as citizens in the society. Dewey's (1938) observation is still relevant: "Collateral learning in the way of formation of enduring attitudes, of likes and dislikes, may be and often is much more important than the spelling lesson or lesson in geography or history that is learned. For these attitudes are fundamentally what count in the future. The most important thing that can be formed is the desire to go on learning." There is a great deal of evidence to support the argument that significant aspects of the future life of an elementary school student (career choice, for example) may be predicted on the basis of his adaptation to the school and his response to the stimulations and constraints by which it attempts to shape his behavior.

One implication of this assumption is that a major instructional component, whether human or nonhuman, when introduced into a school system, modifies the educational context of the school and acquires the potential for socializing children into patterns of interaction with the school and with other institutions of the society. The investigators' interest in the effects of CAI follows from this assumption.

In its role as an instructional medium, CAI represents one component of the human organization of the school. This, in turn, modifies the educational experience deriving from participation in that system. In short, CAI may acquire properties usually attributed to human socializing agents and come to be regarded as an authority figure giving rise to feelings, attitudes, and expectations which are comparable to those toward other authority figures, especially the teacher.

Relationship of attitudes to educational performance. The view of attitudes as significant influences on educational attainment is based on two assumptions: (a) An individual needs to organize his perceptions of the environmental context to achieve an understanding of the new, raw phenomena he perceives, and (b) the individual's information-processing capacity relative to the information available is limited, and he must exercise some selectivity.

The economy theory of attitudes postulates that for a person an attitude system provides the sort of parsimony and direction in handling social experiences that a theory provides to a scientist in his approach to empirical phenomena. Raw phenomena are grouped into implicit and explicit categories in order to draw generalizations useful for thought and action. Like other generalizations, the cognitive components of attitudes involve a simplification of complex phenomena. Such inferences afford the actor the feeling of competence he needs to deal with present and future experiences. Thus, the economy theory of attitudes is a special case of a more general conception of the utility function.

Viewed as analogous to a scientific theory, an attitude system should be amenable to change when new information is obtained. However, attitude systems, like scientific theories, have a high threshold to change (McGuire, 1969). The effects of dissonance on a person's selective exposure to stimuli are that (a) he will seek out information confirming his preconceptions, and (b) when faced with information inconsistent with his own views, he will tend to regard it as less logical, less informed, less interesting, less fair, etc. (Festinger, 1957; Hovland, Harvey & Sherif, 1957; McKillop, 1952).

The significance of this conceptualization for this study is that attitudes developed toward computers in the educational setting are likely to be generalized to noneducational situations and to persist into post-school interactions with technology. The persistence of attitudinal structures has direct implications for the interpretation of the study's results.

The Computer as a Socializing Agent in the School

One aspect of socialization involves the systematic effort to develop an individual's ability to relate to society or subsystems of society. As such it implies acquisition of patterns of behavior, attitudes and expectation states shared and valued by the members of a social group into which one is being socialized. The acquisition process may take place according to a number of different principles of learning, but primarily it involves interaction; that is, a process of two-way give-and-take between a socialization agent and a child. From this standpoint one may identify features which seem to characterize the socialization agent in a complex society. The fact that technology is a major feature of modern industrialized societies gives particular salience to the study of the possible socializing effects of computer instructional programs.

CAI as a component of educational experience. The development of programs designed to utilize computers in instruction was a natural and perhaps inevitable result of a merging of experimental psychology and electronic sophistication. Technology of various and often ingenious forms was used in psychological experiments for many years to present material to subjects under highly controlled and highly systematic conditions. It is perhaps in this arena that computer-assisted instruction was born. For it was there that the systematic and careful planning of input for presentation to human subjects through electronic gadgetry was developed. The application of this kind of approach to educational settings had its major impact through programmed instruction. The speed and versatility of the computer represented a technological advance that made possible the inclusion of elements of teacher behavior in CAI programs. CAI is, after all, a more complex form of programmed instruction. But the changes made possible by the capabilities of the technology represent new forms that differ from previous types of programmed instruction in several fundamental ways.

Computer-assisted instructional programs represent a combination of the technical and mechanical properties of the computer and the properties built into the instructional program itself. It is almost impossible to separate the two. The computer could, of course, be used to present instructional material to the child in a disorganized or clumsy format. It is significant, however, that the programming of material for presentation by elaborate technological equipment carries with it the virtual necessity that such programs be designed to be congruent with the potential of the equipment insofar as possible.

A primary goal of CAI is to present material at a level of clarity, organization, and appeal that only a few human teachers might be able to attain on occasion, and that virtually no one could maintain as stable qualities of his everyday educational practice. This suggests that the quality of the program is determined to a degree by the potential of the instructional medium, and it may not be useful to try to separate the design of the program from the mechanical and technical properties of the machine itself. Therefore, to say that the effect of CAI upon the student is a matter of the "program" is to overlook the fact that the sophistication with which instructional material is organized and presented is contingent upon the versatility of the machine. To a degree then, the impact of CAI represents both the properties of the equipment and the resourcefulness and ingenuities of the program.

Assuming that programs continue to be perfected in the sense of making an optimal use of the principles of management of learning, there is a possibility that they will be used in curriculum areas that deal with values and beliefs, and thus may be used for indoctrination. There may be a significant distinction between the computer as a dispenser of facts and information and the computer as a dispenser of values and political information. If it develops into the powerful instructional tool it is capable of being, there can be no a priori assurance that its role will be confined to the transmission of unbiased information.

The computer as communicator. Since a primary function of the computer in the school is to disseminate cognitive content, its effectiveness as a communicator is contingent upon the way it is evaluated by the message receiver, in this case by the student.

Communicator effectiveness in inducing attitude change has been investigated along three major dimensions: credibility, attractiveness, and power, or "means-control." Kelman (1958, 1961) theorized that these qualities, which make up source valence, correspond to different modalities of receiver motivation, and operate through different psychological modes in inducing attitude change. For example, when a communicator's effectiveness is viewed as resting on his credibility, it is assumed that the receiver is motivated to attain an objectively verifiable "right" stand on a point at issue; thereby his evaluation of the message's veracity would rest on his perception of the communicator's competence or expertness (i.e., his perceived potential to know the "right answer") and trustworthiness (i.e., his perceived motivation to communicate what he knows in an objective, unbiased way). Hence, the messages of a highly credible communicator would be internalized, in the sense that the arguments he uses are learned, and his conclusions integrated and retained in the receiver's belief and value system, even when the communicator has been forgotten or has changed views about the point at issue.

On the other hand, the attractiveness component of communicator persuasibility rests on the assumption that the receiver is motivated to attain (and/or maintain) a gratifying self-concept. In Kelman's view, adoption of the views advocated by the communicator derives from the receiver's feeling that identification with the communicator enhances his own self-esteem. The perceived veracity of the communicator's views thus becomes secondary to his attractiveness to the receiver. Communicator attractiveness has been investigated in terms of the receiver's perception of his similarity to, familiarity with, and liking for the communicator. The maintenance of beliefs acquired through the identification process, therefore, unlike internalization, would depend on the source's continued advocacy of the beliefs and on the extent to which the role relationship established between the source and the receiver maintained its instrumentality and salience. This emphasis on identification may be relevant to human/human interaction, but less applicable to human/machine interaction.

The effectiveness of the power or "means-control" component of source valence rests on the assumption that the receiver regulates his behavior toward attainment of anticipated goals. To the extent that a communicator has, and/or is perceived by the receiver as having, the capability to influence (i.e., enhance or impede) his behavior toward goal attainment, he will be able to obtain the receiver's compliance, i.e., his public acquiescence with the views he advocates, with or without private commitment to them. Attitude change induced in this way is expected to be maintained to the extent that such a power-dependence relationship between source and receiver is instrumental, which means as long as the receiver continues to perceive the communicator as retaining control or sanctioning power over him, concern for conformity on his part, and ability to monitor his compliance.

While the application of this conceptualization to drill and practice programs is limited (restricted to the student's "compliance" in the sense that he tries to work the problems correctly), it has direct and profound implications for possible use of CAI in teaching social studies, history, civics, and other courses which present values, interpretations, and points of view.

The dimensions of credibility, attractiveness, and power, along which a communicator may be differentially valenced, are actually overlapping (McGuire, 1969). For example, the credibility component may reasonably be regarded as overlapping both the power and the attractiveness components. Expertness, for instance, may be thought of as the core of a communicator's perceived power to help the receiver reach a goal. Also, a communicator's power to enhance the receiver's competence through expert tutoring and monitoring (control) of his behavior may constitute the essence of his perceived trustworthiness, and the major source of the receiver's liking for him.

Properties of CAI as a socializing agent.

1. Capability for interaction

Perhaps the feature which contributes most to the machine's potential to function as a socializing agent is its ability to facilitate interaction between a human and the information stored in it by other humans, who no longer participate in the actual exchange. It seems that it is this quality which immediately engages the person operating the computer console.

He discovers that when he gives the machine a meaningful message he can receive a meaningful response. The requirement that the message be meaningful in both directions has obvious parallels in the human interaction which mediates socialization.[2]

2. The computer as a reinforcing agent

A major source of the socializing potential of CAI certainly lies in its ability to affect the learning of curricular content. Several learning principles readily adaptable to CAI programs are being used to create learning situations in which the pupil is likely to acquire the information offered. Specific reinforcements of operant responses are built into these programs. For example, most programs are designed to give the learner immediate feedback regarding the accuracy of his responses; thus, correct responses are immediately reinforced. Further, the material is presented in relatively short sequences or small steps that can be mastered one at a time. Also, since instruction is presented individually, the pupil may proceed at his own pace and quickly achieve his optimum rate of performance and growth. Finally, the sequence of materials presented can be arranged to facilitate the acquisition of concepts and information involved. To the extent that CAI programs are designed to have the power usually held by the human teacher to evoke and reinforce patterns of responses in children, they acquire authority which enhances their potential as agents of socialization.

3. The computer as pseudohuman teacher

CAI programs are usually designed to supplement a number of components of the teacher's contribution to the classroom learning situation. As such,

2 It might be useful to recall here that out of the infinite variability of behavior forms that a child has the potential to develop only certain forms are developed through the socialization process. One could say that in a certain social situation only certain responses are operant--i.e., they are meaningful for this situation and, therefore, enable the individual to relate to other individuals, interact with them or, more generally, attain a goal within the context of that situation.

they include several aspects of the teacher's role. During an instructional session, for example, the computer will use the child's first name; it will also give the child a greeting or a farewell at the beginning and the end of the session; and on special occasions it will include an appropriate holiday greeting, such as "Merry Christmas" or an outline of a tree at Christmas time. One program terminated the session with the comment, "Goodbye, Jane, it's been nice interacting with you." These patterns of personalized verbal address are designed to stimulate the child's interest and curiosity; they may also encourage the child to "humanize" the computer in a teaching-learning situation. This feature may be supplemented by personnel supervising the children working at the terminals. On one occasion, when the machine had broken down, a supervisor was heard to say, "The computer is sick today; the computer is sleepy." No one knows, of course, the children's reaction to such statements.

No one has made a study of the use of "humanizing" techniques in CAI programs and in supervising the children's work at the computer console. Observations during the present study suggest, however, that this is a procedure deliberately incorporated into CAI because of its presumably facilitating impact on the child's contact with the computer or on his readiness to learn from it. It was, indeed, such examples of pseudo-personal messages that initially attracted the investigators' attention to the possibility that the computer might be exercising a socializing role as well as one of imparting information and academic skills. Some of these properties bring to mind the idea of charisma, but it is not clear how this concept applies to CAI.

There are other interactive features of the computer which affect the nature of the machine-student exchange. One of these is the remoteness of the human programmer and his inaccessibility to inquiry or challenge by the pupil. This limits the exchange and may cast doubt on the human-like responses of the program. Perhaps one of the most important qualities of the machine is the fact that it does not accompany its verbal messages with subtle nonverbal cues of approval or disapproval that are likely to be present in almost any human interaction.

In addition to the elimination of such subtle cues, CAI programs do not contain a residue of evaluations based on prior performance; that is, the computer has no "halo effect" in its evaluations. In short, these special capabilities of the machine enable the programmer to utilize certain features of human interaction and also to modify the typical teacher-to-pupil relationship in order to optimize the conditions of the learning process.

4. Motivating and engaging features of CAI

Informal reports and casual observation support the notion that operating the computer terminal has a certain amount of intrinsic interest for both children and adults. There are also indications that, although there is accommodation over time to the process of input-output involved in the operation of the gadgetry of computer terminals, properly designed programs maintain a high level of interest and engagement on the part of the student. This capability of maintaining motivation in interaction with the machine is an important feature of the educational process and has implications for the potential of CAI as a socializing instrument. It is not altogether clear what attributes of the machine are responsible for the high level of interest displayed by students and its maintenance over time. In part, this may follow from some of the characteristics of CAI already described. There may, however, be another feature which contributes to maintaining a high level of interest. This is, in the interaction between the child and the machine, new information is generated which is particular to that exchange. This new information has to do with competence and mastery. Not only does the pupil learn new content from the program, he is continually getting information about whether he has the competence to deal with the materials, the questions, the problems being presented by the machine. This information is, perhaps, a feedback about competence level which in itself may prepare the child for learning, if it is appropriately related to his abilities. Or, it may discourage him, if the level of his competence is much below that expected by the program. Conceivably, interest in whether one knows the right answer or has the ability to master the problem may account for the popularity of various kinds of multiple-answer quizzes and gadgetry.

This essentially interactional aspect of CAI comes about as a result of the experience of exchange between the human and machine units. Presumably it adds to the attraction of CAI for the pupil and thus plays a significant role in establishing the machine as a socializing tool. If it is the machine that offers the problem against which the student can evaluate his level of competence, this feature affords the machine a kind of challenging authority, the authority invested in it by the willingness of the human to judge and evaluate his own response against it.

5. The computer as part of the authority structure of the school

To the extent that CAI conveys knowledge by assigning tasks evaluating performance, and sanctioning certain forms of the pupil's behavior it may come to be regarded as a component of the authority structure of the school.

The social context of the school is organizational in nature, in the sense that it is a system in which differential power or resource capacity is associated with the occupants of various positions in it. As in other organizations, legitimation of the power systems of the school rests on the idea of authority; that is, in attempting to accomplish objectives, the occupants of the various organizational positions rely on normative consent rather than force. A student's interaction with CAI, as with a teacher, rests on (a) a power-dependence relationship in which CAI uses its resource capacity to regulate the student's efforts to reach a goal, and (b) norms and rules governing both the control attempts of CAI and the student's responses to them.

The view of role relationships within the school system as resting on a differential distribution of resource capacity among the participants (or occupants of organizational positions in it) follows from Emerson's (1962) postulate that (a) power is the characteristic of a relationship rather than a person; and (b) in a power-dependence relationship the power of A is proportional to the degree that A can mediate between B and B's goals and inversely proportional to the degree that alternative power-dependence relations are available to B for goal attainment. This conceptualization is particularly relevant to this study since interaction with CAI may generate a power-dependence relationship between the computer and the student. Such a relationship could function as an alternative to the teacher-student power-dependence tie and thereby modify the student's perception of the traditional authority structure of the school.

Implications of the socializing properties of CAI. A central implication of the socializing properties of CAI is that these programs do something more than transmit information and cognitive skills. To the degree that they generate attitudes and develop expectation states in the child, their effect will be felt over a much wider range of behavior than if they were simple information-transmitting instruments.

It has already been suggested that the development of attitudes toward the computer may be accompanied by adjustments in the attitudes of children toward other socializing agents in the school. To the degree that the child is impressed with qualities of the computer, such as the breadth of knowledge and information it can store and manipulate, the rapidity with which it responds, and the factualness of its feedback (evaluations free of subtle cues and "halo effects"), the human teacher and other sources of information (textbooks, newspapers, television, and other mass media) may lose status and impressiveness as sources of influence and control. There may also be changes in the attitudes of the teacher himself in response to the positive attitudes of children toward CAI, and changes in teacher role behaviors. As Hansen and Harvey (1969) envision it, "with the computer assuming the major responsibility for information dissemination, the teacher's role is likely to revolve around human relations, instructional strategies, construction of learning materials, and learning research."

It is, however, the possible transfer of attitudes toward the computer as a source of information in educational settings to machines as sources of information in noneducational contexts that is of more direct interest to this study. Some assumptions which are made about CAI programs, and some of the veracity and validity which the machine gains from its location in an educational setting, might be unjustified when applied to machines in other locations.

The emergence of a high level of confidence in machines as sources of valid information might be useful. But it is by no means assured that the consequences will be benign; it is not possible at this point to know whether the transfer of such attitudes would be in the public interest or in the interest of individuals. But if the central hypotheses and assumptions of the study are valid, such a transfer seems likely.

It is perhaps worth noting that the role of pupil in the classroom--that is, the behavior of an individual pupil toward his classmates, his teacher, and other equipment and rituals of the class--has few parallels outside of school and the formal schooling process. The pupil role behavior a child learns in the school is not functional in many of the situations in which he will be operating as an adult--he rarely finds himself in a classroom-like situation. The responses to technology, however, and the cues which evoke attitudes of trust, resentment, curiosity, etc., toward the computer are likely to recur because of the similarity of the interactional settings outside of the classroom to those operative in interaction with CAI. Cues include anything that clearly identifies that the sources of information have been computerized. Cues and labels which give this impression are very easy to replicate; and it is these cues perhaps more than the size and shape of the room or the console or the typewriter itself, that are of importance.

Future studies are being considered which will examine this tendency to transfer expectations from computer-related formats in educational situations to computer-related formats in other locations. Other studies are being designed to explore the relative credibility of computer output as compared with essentially identical information offered in other forms.

Method

Development of Instruments

One of the purposes of this initial study was to develop suitable ways of obtaining data on the types of orientations, attitudes, and feelings that children hold in interaction with CAI. The conceptual and theoretical issues discussed in the previous section were developed throughout the course of the study. There was less opportunity to develop and revise the instruments and techniques for obtaining data since these necessarily had to be stabilized in order to get the sort of data needed for exploratory purposes. The instruments that were developed, however, were based on a number of theoretical and conceptual considerations and represent an attempt to bring to bear both methodological and theoretical perspectives in this exploratory study. This section describes the major instrument used and attempts to identify the combinations of items devised to obtain data along dimensions indicated in the previous section. The instrument described here is being revised; any attempt to replicate or to extend this project should take into account that this preliminary questionnaire will be substantially modified in the staff's further investigations.

Initial attempts to develop instruments were based, of course, upon preliminary interviews, and upon some observations of children in relation to and interaction with the computer consoles. The questionnaire and the final form of the interview questions used in the study are included in Appendixes 1 and 2. The presentation of items in this section follows more clearly the conceptual orientation of the staff at the present time than it does the actual physical format of the questionnaire itself.

One of the instrumentation techniques employed to aid in interpreting was the use of parallel items and item clusters in obtaining responses not only to the computer but also to other sources of instructional information--the teacher, the textbook, T.V. news, and to a lesser extent, parents. These comparisons give baselines of responses to somewhat more familiar objects and allow some understanding of the parameters of responses to CAI and the computer.

The meaning of the computer and other sources of socialization. Since the concepts teacher, computer, television news, textbook, and parents are quite heterogeneous, comparison among them may appear to be logically arbitrary. However, devices such as Osgood's (1957) semantic differential allow exploration of the connotative meaning of concepts and the degree to which positive or negative feelings are associated with them.

In this study, ten semantic differential scales were applied to the concepts teacher, computer, T.V. news, and textbook. Five of these scales referred to the evaluation dimension (gives right answers-gives wrong answers, fair-unfair, bad-good, like-dislike, and confusing-clear), three to the potency dimension (hard-soft, big-small, and difficult-easy), and two to the activity dimension (fast-slow, cold-warm).

The quesionnaire also includes several other items devised to investigate the students' evaluative perceptions of the computer as an agent of socialization.

The computer as source of information and instruction. In line with the view that socialization occurs in situations where participant units have differential resource capacity,[3] items were devised to investigate the students' evaluative perception of the machine itself, and its uses in CAI, in relation to properties involved in two major functions: information dissemination and monitoring of the

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[3]Resource capacity encompasses all the kinds of objects (e.g., texts and audiovisual materials) and behaviors instrumental to goal attainment that the participants bring to a power-dependence relationship, including information and behaviors reinforcing or inhibiting responses made by the participants during their interaction.

performance of tasks involved in the process of acquisition of the information available. As a source of instruction the computer, like human communicators, may be evaluated in terms of its perceived credibility, and its instrumentality (attractiveness or effectiveness as a teacher) to the receiver's goal-oriented behavior.

Previous research on human communicators has used variables such as intelligence, educational and professional attainment, social status, and age to assess the impact of expertise upon communicator persuasiveness. These variables were found to have an impact on communicator persuasiveness "even when the area of expertise is irrelevent to the point at issue, and where the cues for it are minimal" (McGuire, 1969).

In this study, the questionnaire items devised to explore expertise of the computer dealt, for example, with (a) amount of information, (b) validity or correctness of the information transmitted, (c) capability to answer almost all questions, and (d) likelihood of making mistakes. The concept of trustworthiness was defined as disinterest and intent (or lack of intent) to persuade. Trustworthiness was inferred from items dealing with the motivating power of the learning situation offered by the computer. These items were designed to explore liking for the style of interaction and preference for the medium involved in each of these instructional situations. They also dealt with awareness of and satisfaction with the way tasks are assigned, and student performance evaluated in both teacher and CAI instructional situations. In other words, trustworthiness was not distinguished from attractiveness of, or liking for, CAI as compared to other sources or media of instruction.

In addition, the investigators explored the possibility that both expertise and trustworthiness of sources of instruction may be carried out to extremes, in the sense that students may attribute to both CAI and teacher charismatic qualities--such as infallibility, an almost magical capability to bring about desirable effects, limitless endurance in work as well as unpredictability, and unresponsiveness to student attempts to modify the course of action followed by the source.

Below are listed the items designed to explore the dimensions of expertise, trustworthiness, and charisma of the computer as compared to other sources of information and instruction.

Expertise:

1. How much information does the (computer, teacher, T.V. news) have?
2. How often does the (computer, teacher, T.V. news, textbook) make a mistake?
3. How often do you disagree with what the (computer, teacher, T.V. news) says?
4. Computers are smarter than people.
5. Computers are smarter than textbooks.
6. Most big machines are really run by computers.
7. I believe the (computer, teacher, T.V. news) will always be right.
8. A (computer, teacher) can answer almost all your questions.

Trustworthiness:

1. Do you like doing math problems with the (computer, teacher)?
2. I would prefer to learn math from the (computer, teacher, T.V., textbook).
3. The idea of using a computer scares me.
4. Most students think that computers are hard to work with.
5. Most of my friends don't trust (computers, teachers, T.V. news).
6. How often does a (computer, teacher) give you enough time to answer a question?
7. When a (computer, teacher) gives you math problems to do, how often do you understand what you are supposed to do?
8. When you have done a math problem, does the (computer, teacher) tell you if you are right or wrong?
9. Are you happy with having the (computer, teacher) choose which math problems to give you?
10. Are you happy with the scores the (computer, teacher) gives you on math problems?

Charisma:

1. A computer sometimes acts like a person.
2. A (computer, teacher) could help you improve your math grades in one month.
3. A (computer, teacher) never gets tired of working with you.
4. How often do you know what a (computer, teacher) is going to do next?
5. If you wanted to change something in a (computer's teacher's) lesson, do you think you can change it?
6. How often does a (computer, T.V. set) break down?

Two items (4 and 7) under expertise were also expected to convey the idea of charisma. Items 6 through 10 under trustworthiness were also used to test specific hypotheses about the role of the computer as an authority figure in the school (see next paragraph). Finally, items 6 (expertise) and 3 through 5 (trustworthiness) yielded ambiguous data which are not analyzed.

The computer as an authority figure. As indicated earlier, the investigators assumed that CAI becomes part of the authority structure of the school organization. Organizational sociologists (Scott, Dornbusch, Bushing, & Laing, 1967; Dornbusch & Scott, in press) suggest that determining the sources of legitimation of the exercise of power by the participants is important to understanding the functioning of an organization. They focus attention on (a) those superiors in the system whose rules or beliefs support the exercise of power(the authorization process); and (b) those subordinates subject to and whose beliefs support the exercise of power (the endorsement process). Scott and his colleagues suggest that in a power-dependence relationship within an organization, attempts to achieve control over member activities toward goal attainment are particularly prevalent in the process of task performance. They define four components of this process--allocating a task, setting criteria for evaluation, sampling (or supervising task exucution), and appraising task performance--which can be regarded as authority rights or functions that the participants may be seen as authorized and endorsed to assume.

With respect to CAI, one may assume that there is a set of norms on the basis of which school officials authorize the computer to regulate student behavior toward certain goals, i.e., mastery of subject matter, satisfactory evaluations or grades, sense of competence, etc. In studying the attitudes of students toward CAI, one must (a) establish whether students perceive the computer as having the right to exercise control over them; (b) establish which functions the computer may exercise; and (c) obtain students' estimates as to whether these functions or rights are legitimate, that is, are <u>authorized</u> (supported by higher school authorities), <u>endorsed</u> (supported by other students), and have <u>propriety</u> (are considered by the respondent as appropriate).

View of authority functions: The items designed to explore the students' perception of the functions exercised by the computer as compared to other authority figures (teacher, parents) are listed below:

1. (The math teacher, computer, your parents) punish(es) you when you do something wrong.
2. (The math teacher, computer) chooses which math problems to give you.
3. (The math teacher, computer) shows you how well or how poorly you are doing in math problems.
4. (The math teacher, computer, your parents) help(s) you learn to do math problems.
5. (The math teacher, computer, your parents) show(s) interest in the math work you do.
6. (The math teacher, computer) gets impatient with you.
7. (The math teacher, computer, your parents) help(s) you get better math grades.
8. (The math teacher, computer, your parents) check(s) your math problems.
9. (The math teacher, computer, your parents) correct(s) your behavior.

Perception of task allocation: The following items were designed to investigate the students' views of the way tasks are allocated by the computer as compared to the teacher, and their degree of satisfaction with these procedures:

1. When a (computer, teacher) gives you math problems to do, how often do you understand what you are supposed to do?
2. How often does the (computer, teacher) give you problems which are too hard?
3. How often does a (computer, teacher) give you enough time to answer a question?
4. How often do you know what a (computer, teacher) is going to do next?
5. If you wanted to change something in a (computer's teacher's) lesson, do you think you could change it?
6. Which one decides what math lessons you get from the computer? Response categories to be marked with "Yes," "No," or "Don't Know": The math teacher; Somebody at Stanford; The score I got the day before; The computer supervisor; The computer.
7. Are you happy with having the (computer, teacher) choose which math problems to give you?

Note: Items 4, 5, and 6 were included to explore the students' feelings of efficacy with respect to task allocation, and item 7 is an explicit measure of student satisfaction with task allocation as performed by the computer and the teacher.

Perception of computer as establishing criteria: Five criteria were presented and students were asked to rate their importance from their own point of view, the teacher's, and the computer's. These were:

1. How fast I do math problems.

2. If I get them right.
3. If I get them all done.
4. Having a neat paper.
5. Other things such as coming in late, being absent, talking too much, etc.

View of computer as evaluating performance: The students' views regarding the function of appraising as performed by the computer and the teacher were explored using the following questions:

1. When you have done a math problem, does the (computer, teacher) tell you if you are right or wrong?
2. Do you think that the scores you get on math problems from the (computer, teacher) change your math grade?
3. How much do you care about the scores the (computer, teacher) gives you on math problems you do?
4. Are you happy with the scores the (computer, teacher) gives you on math problems?

Perception of consequences of poor performance: To explore the students' perception of various modalities of sanctions following poor task performance, and their evaluation of the relative seriousness of these sanctions, the following items were used:

1. What can happen to students who do a poor job on math problems given by the (computer, teacher)?
   Response categories to be marked by "Yes," "No," or "Don't Know:"

   (a) They get poor grades.
   (b) The teacher frowns at them.
   (c) The teacher won't like them.
   (d) They have to stay after school.

2. How bad is this?

   (a) Getting poor grades.

(b) Getting frowns from the teacher.

(c) Not being liked by the teacher.

(d) Having to stay after school.

Each of these alternatives was rated on a 4-point scale (from "Not bad at all" to "Very bad").

Legitimacy of computer functions: The following three items were included in the questionnaire as measures of propriety, authorization, and endorsement of the computer function of appraising student performance in math:

1. If you could choose, would the computer score more, the same, or less of your math problems?
2. If your math teacher could choose, would the computer score more, the same, or less of your math problems?
3. If your friends could choose, would the computer score more, the same, or less of their math problems?

Design of the Research

The questionnaire was administered in a post hoc design. The investigators had no control over the allocation of subjects to the treatment (CAI) and control (Non-CAI) groups. The research group came from a junior high school in the Bay Area and was predominantly from Mexican-American, lower socioeconomic background. The students assigned to the CAI program were selected by the vice-principal of the school upon recommendation of their math teachers. The criteria used were (a) achievement level in math as judged by the teachers, and (b) standard test scores. The CAI program was used in this school as a remedial course in the basic arithmetic operations of addition, subtraction, multiplication, and division. While the students came from grades seven, eight, and nine, they were working on math lessons originally designed for fourth, fifth, and sixth graders. Only students who had immediate need for such remedial instruction were assigned to the program. The total number of such students was limited by the availability of teletype equipment.

The questionnaire was administered to six math class groups, a total of 189 students. Of these, 50 had taken CAI for at least one and up to two school years. Although the remaining 139 Non-CAI students were generally performing at a somewhat better level in math than their CAI classmates, the entire group should be regarded as a selected population.

The program to which the CAI students were assigned is not instructional in the strict sense of the term. Students practice arithmetic operations of addition, subtraction, multiplication, and division. After each exercise is performed, the solution is instantly evaluated by the computer and, if correct, a new exercise or problem is presented. If the solution is not correct, the words "No, try again" are typed out by the teletype. If the solution is not given within a certain time limit, the words "Try again" are repeated. The students get a certain number of exercises in each session. At the end of the session the percentage of correct responses within a certain period of time is typed out by the teletype at the bottom of the page. A sample page of this program is shown in Appendix 3.

The design was structured to permit comparisons of attitudes toward the computer and toward CAI of students who had had experience in the program with those of students who had not been involved in CAI. This design permitted analysis of data relevant to the following questions:

1. What are the parameters of the images students hold of the computer and of CAI?
2. What is the effect of participation in the CAI instructional program on images of the computer and of the program?
3. What is the image of the computer and CAI relative to other sources of information?

Data Gathering Procedures

As indicated above, the students involved in CAI in the school in which the study was conducted were those whom the classroom teacher thought would be particularly helped by this kind of supplementary practice in mathematics. In negotiations with the school to obtain permission to conduct the study, the staff discussed with the vice-principal the aims of the study and the techniques planned and shared with him the preliminary copies of instruments that were available. In these early discussions the procedures planned to assure confidentiality of the information sought were also described. To keep answers confidential, the questionnaires taken to the university from the school contained only the students' code numbers, not their names. A list of both code numbers and names was kept on file at the school in the event that the research staff might wish to obtain other information or do a follow-up at some future time. This procedure permits the staff to examine the data without knowing the identity of the individual students; the records kept at the school contain the code number but not the data obtained. In this way there is no possibility that individual students can be identified. The types of feedback to be given to the school of the results of the study were also discussed.

The questionnaire was administered to students in their normal classroom grouping to avoid any suspicion that the CAI students were being considered as a special group. Students were assured, of course, that their responses would remain anonymous and would not be shared with the research staff and the school personnel except as group results. Confidentiality was achieved by printing the code number at the top of the front page of the questionnaire and also on the lower half of the page. Students were asked to print their name and grade in the appropriate space on the bottom half of the page, and this was later torn off the questionnaire booklet. This part of the sheet was left with the school; the questionnaire booklets were returned to the university for transfer to IBM cards.

In addition, a 10% sample of the respondents was selected for more intensive interviewing. These interviews were designed as an independent check upon the dimensions examined by the questionnaire and to provide additional responses on aspects of the students' attitudes which were not included in the questionnaire items themselves. An equal number of males and females, CAI and Non-CAI students, spread over the three junior high school grades were interviewed.

Demographic data were taken from the school files for each student who had filled out a questionnaire. These data included each student's sex, grade, achievement in math, intelligence test scores, socioeconomic background, ethnicity, age, and identification of his math teacher. Tables 1 and 2 show the characteristics of the sample on these various demographic items.

Preliminary Analysis of Data--Effect of Independent Variables

Data obtained through the questionnaire were analyzed by the usual univariate categories--distributions, measures of central tendency, and measures of variance. To determine the extent to which sample variables such as sex, grade level, ethnicity, and the CAI/Non-CAI dichotomy were significantly associated with the questionnaire variables, chi-squares were computed between the distributions of responses on each questionnaire item by each of the above-mentioned sample variables--i.e., CAI vs. Non-CAI, male vs. female, Mexican-American vs. non-Mexican-American, and seventh vs. eighth and ninth grade.

These two-way cross tabulations showed that the proportions of significant chi-squares between questionnaire items and idependent variables were: CAI/Non-CAI, 27%; grade, 19%; sex, 13%; and ethnicity, 3% of the total possible in each instance. That is, the proportion of significant relationships produced by the variables of CAI/Non-CAI, grade, and sex were above the expected 5% by chance, assuming that the questionnaire variables were independent of each other. The CAI/Non-CAI dichotomy accounted for the greatest proportion of significant relationships (at or beyond the .05 level of statistical significance), followed by grade and sex, in that order. The relationships produced by ethnicity were few and cannot be confidently interpreted as reflecting real differences in the distributions of item responses due to ethnicity.

TABLE 1

Characteristics of the Research Group

Sex		Male	Female				Totals
	N	100	89				189
	%	53	47				100
Age		Below 13.6	13.7-14.6	14.7 & over			
	N	68	84	37			189
	%	36	44	20			100
Grade		7th	8th	9th			
	N	79	87	23			189
	%	42	46	12			100
Level of Performance in Math[a]		Low	Intermediate				
	N	32	157				189
	%	17	83				100
SES		Unskilled	Semiskilled				
	N	76	113				189
	%	40	60				100
Ethnicity		Mex.-Amer.	Oriental	Black	Anglo-Amer.	Other	
	N	139	9	8	27	6	189
	%	74	5	4	14	3	100
SCAT[b]		0-15	16-30	31 & above			
	N	58	41	46			145[c]
	%	40	28	32			100
CAI vs. Non-CAI		CAI	Non-CAI				
	N	50	139				189
	%	26	74				100

[a]Math level of individual students was rated by math teachers.
[b]SCAT score groupings correspond to midpoints of percentile band.
[c]School files included SCAT scores for only 145 (out of 189) students.

TABLE 2

Characteristics of CAI and Non-CAI Groups

		CAI Group				Non-CAI Group			
Sex		Male	Female		Totals	Male	Female		Totals
	N	22	28		50	78	61		139
	%	44	56		100	56	44		100
Grade		7th	8th	9th		7th	8th	9th	
	N	18	24	8	50	65	60	14	139
	%	36	48	16	100	47	43	10	100
Level of Perform-ance in Math[a]		Low	Intermediate			Low	Intermediate		
	N	20	30		50	12	127		139
	%	40	60		100	9	91		100
SCAT[b]		1-15	16 & above			1-15	16 & above		
	N	24	15		39[c]	34	72		106[c]
	%	62	38		100	32	68		100

[a] Math level of individual students was rated by math teachers.
[b] SCAT score groupings correspond to midpoints of percentile band.
[c] School files included SCAT scores for 39 (out of 50) CAI students and 106 (out of 139) Non-CAI students.

To examine the possibility that differences by CAI/Non-CAI might be confused with differences by other sample variables -- namely, sex, level of intelligence, and ethnicity -- three-way cross-tabulations were performed for all the questionnaire variables (by sex by CAI/Non-CAI, by intelligence by CAI/Non-CAI, and by ethnicity by CAI/Non-CAI) and chi-squares were computed between the distributions of responses. This analysis indicated that there are virtually no confounding (interactional) effects of sex, intelligence level, or ethnicity on the differences found between the distributions of responses by the CAI and Non-CAI groups. In other words, in virtually no instances did differences between CAI and Non-CAI groups seem to be due to unequal distributions of males vs. females within the CAI/Non-CAI dichotomy. Rather, it was the CAI/Non-CAI dichotomy which seemed to create artificial differences between the distributions of males and females. Of the total significant chi-squares found in the three-way cross-tabulations of sex by CAI/Non-CAI (nine for the CAI group and 16 for the Non-CAI group), 12 were on variables on which the two-way cross-tabulations had revealed significant differences between the distributions of males and females; on only three of these 12 variables were the two-way distributions by CAI/Non-CAI also significantly different.

A similar situation appeared in the analysis of intelligence level and ethnicity. The ethnicity by CAI/Non-CAI by variables analysis yielded nine significant chi-squares for the Non-CAI group and five for the CAI group. However, only two of these pertained to questionnaire items on which the two-way cross-tabulations had indicated significant differences between CAI and Non-CAI groups, and on only one questionnaire variable did a significant difference found in the distribution by ethnicity by CAI/Non-CAI correspond to a significant difference by ethnicity in the two-way analysis. Apparently, it was a combination of the factors ethnicity and CAI/Non-CAI which contributed to produce significantly different three-way distributions.

The factor of intelligence level was not used in the two-way cross-tabulations because intelligence scores were available for only 145 (39 CAI and 106 Non-CAI) students of the total research group of 189. In the three-way cross-tabulations of intelligence by CAI/Non-CAI by variables, four significant relationships were found for the CAI group and 14 for the Non-CAI group. However, on only one questionnaire variable were the distributions of both CAI and Non-CAI groups significantly different by level of intelligence. The latter finding, in conjunction with the fact that the proportion of significant chi-squares obtained for the CAI group was below the proportion of 5% which is expected by chance alone, and that the corresponding proportion for the Non-CAI group was barely above chance level, led us to the tentative conclusion that the confounding effect of level of intelligence on the distribution of responses by CAI/Non-CAI was negligible.

Since the CAI/Non-CAI dichotomy yielded the greatest proportion of significant differences in the distributions of responses to the various questionnaire items, further computation of univariate statistics (i.e., means and standard deviations) was completed for CAI and Non-CAI groups separately. The next stage of the analysis included computation of correlational matrices and factor analysis for the purpose of determining clusters of items to be used in the analysis and interpretation of the results. The grouping of items did not rest entirely on statistical grounds; the rationale underlying the selection of items in some cases indicated item clusters on an a priori basis. These a priori groupings were used if the correlations among the items involved were generally significant and in the expected direction.

The general approach taken by the project staff during this phase was to attempt to establish parameters and to obtain information about the profile and pattern of orientations toward the computer and CAI. In this sense the study provides results of a descriptive and parameter-establishing nature which will permit hypothesis-generating as well as hypothesis-testing operations.

There are a number of qualifications to the extent to which these findings can be generalized. One is that these data come from students involved in a program of arithmetic drill and practice and may not apply to tutorial or other instructional CAI programs. The results are also based on a junior high school that draws from a working-class ethnic population, and it is not known at this point how similar these responses would be to responses of children from other socioeconomic and ethnic backgrounds. These qualifications and the post hoc nature of the design itself should be kept in mind in considering the results described in the following section.

Results

The Image of the Computer

> "[Computers] have a bunch of switches . . . all kinds of tape recordings . . . all kinds of lights and buttons . . . they look big . . . big doors with lots of lights on, with papers to record things . . . they know . . . if you ask a question, they will answer, they know what you're talking about."
>
> "They give you smart answers back . . . they figure out math problems, maybe history problems . . . social studies, language . . . spelling, I guess . . . reading, science . . . maybe it could diagram things, like in sport or anything."
>
> (Interview excerpts)

One of the central questions of this study is whether the concept computer has a meaning for children which goes beyond the impact of the information and skills it transmits when used in instruction. Is there an image of the computer in the child's mind? Has the computer, as used in education, in business, in science, in rocketry, and as represented by the public press, television, and other mass media in news reports, stories, cartoons, and motion pictures, come to have a meaning for the population quite apart from the specific applications of its versatile technology? Or is the significance of the use of computers in instruction to be understood as entirely contingent upon the specific properties of each CAI program?

Perhaps McLuhan's suggestion that the medium itself contributes to the message and to shaping the impact it has upon an audience is relevant to this issue. The core of the research staff's argument -- that the computer may carry messages, or overtones of meaning, beyond those intended by the programmer -- does not attempt to prejudge whether such effects, if they exist, will be good or bad. Rather, it indicates the context in which the data of this section should be understood.

One approach to this question is to inquire about the image of the computer held by students who have had direct experience of CAI (CAI group) as compared to the image held by students who have not had such experience (Non-CAI group). This approach implies that the two groups are expected to differ in some specific ways. Leaving aside for the moment the possibility that the images of both groups may be contingent upon several important mediating variables,[4] the investigators hypothesized that CAI and Non-CAI students differ primarily in terms of the specificity and clarity of their ideas about, and orientations toward, the computer in general and CAI in particular. In other words, it seemed reasonable to expect that experience with CAI influences the students' attitudes toward computers and CAI, and that this influence manifests itself in observable ways, primarily through its contribution to shaping the cognitive components of these attitudes.

<u>The effect of experience with CAI upon the specificity of students' image of the computer.</u>

> "I was scared, I thought I could do something wrong and make it break."
>
> "Well, now it's a lot easier 'cause I really know how to work it and everything . . . I like it . . . not scared anymore . . . it's not too much . . . you know what you're doing."

(Interview excerpts)

A gross estimate of the effect of experience with CAI comes from the proportion of "Don't know" responses or nonresponses to questionnaire items. The proportions of such "No opinion" reactions were expected to vary both by sampling groups (by CAI vs. Non-CAI) and by content of the items. It was expected, first, that items inquiring

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[4]The images of CAI students, for example, may be contingent upon variables pertaining to the students themselves, the timing of their exposure to CAI, the properties of the CAI program, and other characteristics of the context in which CAI has been experienced.

about the computer would yield substantially greater proportions of "No opinion" reactions from the Non-CAI than the CAI group, and second, that the frequencies of Non-CAI "No opinion" responders would vary depending on the item content -- items dealing with the specifics of the CAI program used at the school were expected to yield the highest percentages of "No opinion" reactions on the part of Non-CAI students.

The data shown in Table 3 generally confirm these expectations. Over all items dealing with the computer, the proportion of "Don't know" responders and nonresponders was consistently higher for the Non-CAI than the CAI group. On the other hand, there were substantial variations in the percentages of Non-CAI "No opinion" responders across the various items. The highest percentages of such "No opinion" reactions by Non-CAI students pertain to items inquiring about specific aspects of the CAI program operating at the school; on items, however, which did not presuppose experience with this program the percentages of "No opinion" reactions were much lower, suggesting that the concept <u>computer</u> does have a meaning (though perhaps less clear) for a substantial proportion of students who have not had the experience of taking instruction through a computer terminal.

On the basis of these findings it was concluded that comparisons between CAI and Non-CAI students would be worthwhile, especially on those questionnaire items on which a quite large proportion of Non-CAI students gave responses other than "Don't know."

<u>The meaning of the concept "computer."</u> The data obtained through the ten semantic differential scales on the concept <u>computer</u> are shown in Table 4 and Figure 1. On almost all scales, CAI and Non-CAI students rated the computer almost equally favorably. The only instances in which the means of the two groups differed significantly were the scales "like-dislike" and "big-small." In the first instance, CAI students appeared to like the computer somewhat more than Non-CAI students; the difference between the means of the two groups was significant at the .05 level. On the scale "big-small" the difference between the mean

TABLE 3

Proportions of "No Opinion" CAI and Non-CAI Responders by Categories of Items Inquiring About the Computer and CAI[a]

Item Numbers Grouped by Content[b]	% Range of "No Opinion" Responders	
	CAI	Non-CAI
1. Information about Computer Functions		
(Item Nos.: 122,125,128,130,132,135,137,140,143)	4-38	69-87
2. Image of Computer		
(Item Nos.: 231,232,233,238,240-243,245,247 254,257,264,347,349,356,357,360)	0-22	31-53
3. Sanctions following poor performance on Computer Allocated Tasks		
(Item Nos.: 321-324)	16-28	42-56
4. Task Performance Evaluation Criteria Attributed to Computer		
(Item Nos.: 341-345)	2-16	32-46
5. Image of Specific Properties of CAI Program		
(Item Nos.: 235,249,251,258-262,267,269, 271,330,351,352)	2-32	43-78

[a]Proportion of "Don't know" responders and nonresponders.
[b]For specific content of each item see questionnaire in Appendix 1.

scores of the two groups was larger ($p < .001$). The mean score for the Non-CAI group ($\bar{X} = 2.27$), suggests that these students tended to perceive the computer as "big" rather than "small"; it should be noted, however, that a sizeable proportion (49%) of this group marked the middle point of the scale indicating that they were undecided. On the other hand, while the mean score for the CAI group suggests a tendency for the group to be undecided ($\bar{X} = 3.14$), the distribution of responses indicates that, in fact, these students' opinions were almost equally divided between the two opposite sides of the scale and only a small proportion (28%) of this group were actually undecided (see Table 4). Apparently, the responses of Non-CAI students reflect on the one hand the fact that many of them have not seen computers at all, and on the other, a tendency for those who have seen computers to perceive them as big rather than small. In contrast, many CAI students seemed to identify the computer with the teletype on which they work at school, whereas others appeared to be able to distinguish between the computer itself and its extensions, such as the teletype.

In conclusion, the profiles of means for CAI and Non-CAI students were nearly identical. These findings suggest that experience with CAI does not alter significantly the image of the computer that students seem to have formed prior to their contact with the program. This conclusion runs counter to the view that the specific properties of the program determine the students' image of the computer.

The level of responses to the semantic differential scales is an important indicator of how favorable or unfavorable is the general image of the computer held by the students.[5] In general, both CAI and Non-CAI students like the computer and perceive it as giving right answers, being fast, fair, and good. When the mean scores of each group are rank ordered from the most extreme to the least extreme, four of the five scales with the most extreme means refer to the evaluation dimension (see Figure 1). In other words, four of the five evaluation scales elicited clear-cut responses, suggesting that the items sampled to tap the evaluation dimension captured some of the most pervasive ideas that CAI and Non-CAI students had about the computer.

---

[5] This concern with level of responding is to be distinguished from differences in responses between CAI and Non-CAI students.

TABLE 4

Image of the Computer: Semantic Differential
(Distributions and Means for CAI and Non-CAI Groups)

Scale	Sample Groups	Percent Distributions 1	2	3	4	5	$\bar{X}$	t[a]
1. Soft-Hard	CAI	18	16	18	18	29	3.23	
	Non-CAI	8	7	51	7	27	3.36	0.648
2. Fast-Slow	CAI	64	10	8	10	8	1.88	
	Non-CAI	50	10	36	2	2	1.96	0.433
3. Gives right answers-Gives wrong answers	CAI	72	8	14	0	6	1.60	
	Non-CAI	61	7	30	1	1	1.73	0.790
4. Fair-Unfair	CAI	56	18	10	6	10	1.96	
	Non-CAI	50	15	33	1	1	1.87	-0.519
5. Good-Bad	CAI	62	10	14	4	10	1.90	
	Non-CAI	44	10	42	2	2	2.09	0.984
6. Warm-Cold	CAI	20	8	41	6	24	3.06	
	Non-CAI	11	10	58	2	19	3.08	0.099
7. Like-Dislike	CAI	52	15	21	4	8	2.02	
	Non-CAI	30	11	53	1	5	2.41	2.007*
8. Clear-Confusing	CAI	38	14	18	6	24	2.64	
	Non-CAI	31	8	38	8	15	2.68	0.142
9. Big-Small	CAI	26	6	28	8	32	3.14	
	Non-CAI	38	7	49	1	5	2.27	-4.082***
10. Easy-Difficult	CAI	38	16	16	10	20	2.58	
	Non-CAI	21	11	54	4	10	2.69	0.515

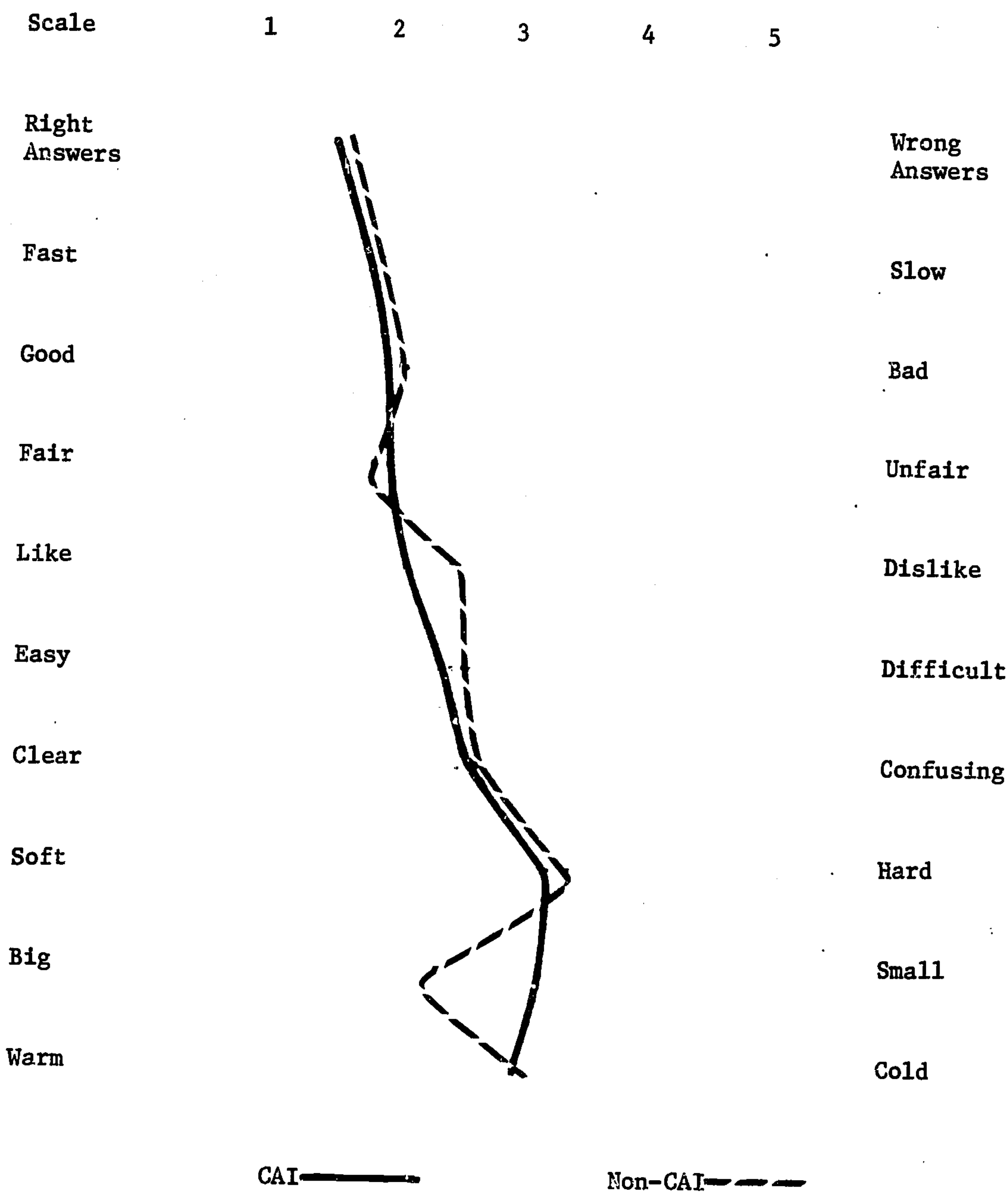
[a]Two-tailed t

*p $<$ .05

***p $<$ .001

FIGURE 1

Image of Computer
(CAI and Non-CAI Groups)



The only nonevaluation item included in the five most extreme scale means referred to the computer as being "fast" as opposed to "slow." This scale recorded the second most extreme mean score, thereby giving evidence for the importance of this feature of the computer in general, and the CAI program in particular. That this scale loads highly on Osgood's activity factor suggests that had more items drawn from this factor been included in the questionnaire then the activity dimension might have emerged as a significant aspect of the students' attitudes toward the computer.

As for the least extreme scales, most were in a direction indicating a favorable opinion about the computer. If anything, the computer was seen as "easy" rather than "difficult," "clear" rather than "confusing," and "hard" rather than "soft." As was discussed above, there were split opinions over "big-small." Finally, "cold-warm" was placed at the neutral point of the scale, suggesting that the majority of students considered the computer as being neither "cold" nor "warm" (see also Table 4).

<u>The computer as a source of information and instruction.</u>

> "Oh, the computer knows everything about math . . . reading, history . . . math, English, social studies, different languages . . . lots of things."
>
> "It doesn't know any more than human beings do."
>
> (Interview excerpts)

Earlier in this report, it was suggested that a major dimension of the computer's potential to exercise the role of a socializing agent lies in the fact that it is an effective instrument of information processing and dissemination. As such, it may come to be regarded as a source, not simply a channel, of information dissemination, and thus be evaluated in terms similar to those applying to human communicators. It can be inferred from the previously reported data on the semantic differential, in particular on the scales "Gives right answers-gives wrong answers" and "fair-unfair," that the computer may be thought of as a source of information and instruction and may, therefore, be valenced along the dimensions of expertise and trustworthiness. On these scales, the proportions of both CAI and Non-CAI students who recorded clear-cut favorable responses were high enough to suggest that correctness of the information transmitted and fairness are specific characteristics of the image of the computer as an instrument of information processing and instruction.

This section contains an analysis of data based on questionnaire items devised to explore the students' views about computer expertise and trustworthiness. In addition, this section contains data drawn from items designed to explore the possibility that confidence in the computer's expertise and trustworthiness may go beyond a realistic appraisal of its capabilities and limitations and become a view of the computer as endowed with charisma.

1. Expertise

> "[Computers get their information] ... from the people in Stanford working the big computer ... I don't know, I guess from real smart, intelligent people who want to make creators (sic) ... maybe professors."
>
> "Computers are programmed by human beings, so they're not smarter than humans."
>
> "It's possible [that the computer makes mistakes], but not probable ... I don't think it would unless there is something wrong with the wire."
>
> (Interview excerpts)

The items included in the questionnaire to explore the students' views about the expertise aspect of computer credibility are listed in Tables 5 and 6. The matrix of Pearson's product moment correlations among these items (see Table 5) shows that the proportion of significant coefficients is greater than chance for both the CAI and Non-CAI groups, especially for the former. Of a total 28 coefficients for each group, sixteen (57%) were significant (at .05 or better) for the CAI group, and eight (28%) for the Non-CAI group. These data suggest that these items may indeed convey the idea of a quality of the computer that could be labelled expertise.

TABLE 5

Correlations Among "Computer-Expertise" Items for CAI and Non-CAI Groups[a]

Items	Sample Groups	1	2	3	4	5	6	7	8
1. Gives right answers-Gives wrong answers.	CAI	1.00							
	Non-CAI	1.00							
2. A computer can answer almost all your questions.	CAI	.42**	1.00						
	Non-CAI	.05	1.00						
3. Computers are smarter than people.	CAI	.41**	.41*	1.00					
	Non-CAI	.24*	.15	1.00					
4. Computers are smarter than textbooks.	CAI	.37*	.39*	.09	1.00				
	Non-CAI	-.07	.38***	.06	1.00				
5. How often do you disagree with what a computer says?	CAI	.25	.28	.38*	.35*	1.00			
	Non-CAI	-.15	.19	.06	.05	1.00			
6. How much information does a computer have?	CAI	-.38**	-.60***	-.43**	-.34**	-.26*	1.00		
	Non-CAI	-.07	-.32**	-.29*	-.11	.00	1.00		
7. I believe a computer will always be right.	CAI	.31*	.25	.17	.44**	.38**	.28	1.00	
	Non-CAI	.10	.29*	.25*	.13	.02	-.23	1.00	
8. How often does a computer make a mistake?	CAI	.09	.14	.36*	-.21	.12	-.16	.10	1.00
	Non-CAI	.11	.30*	.10	.15	.20	-.09	.38**	1.00

[a]The sign of r's reflects the direction of the scale. See questionnaire (Appendix 1).

* = $p < .05$
** = $p \leq .01$
[illegible] = $p < .001$

Comparison of the mean scores of CAI and Non-CAI students on these items indicates no substantial differences between the two groups (see Table 6). The only exception to this generalization pertains to the item inquiring about the amount of information that the computer is believed to have. On this item, Non-CAI students, compared to their CAI peers, appeared to be somewhat more enthusiastic in their estimates of the computer's "erudition." However, the difference between the two means, although significant ($p < .05$), was not very large.

These findings lend some additional support to the view suggested in the preceding section that students come to CAI with certain preconceptions about the computer which are not substantially altered by their participation in CAI. Further data are needed, of course, from students of different age levels, participating in a variety of CAI programs, and at varying lengths of time, to test the generalizability of this tentative conclusion.

The level of means pertaining to these items suggests that both groups (CAI and Non-CAI) have positive views about the computer's expertise. Thus, both groups appeared to be convinced that the computer gives right answers and both tended to agree rather than disagree with the idea that the computer is "smarter than textbooks," "will always be right," and "can answer almost all your questions." Further, both groups appeared to expect the computer to have a large amount of information, to make mistakes rather infrequently, and to give messages with which they would seldom disagree. However, the statement, "Computers are smarter than people," elicited conflicting opinions from both groups.

Examination of the distributions of responses to these items also seems worthwhile to gain a clearer understanding of the data. For example, it is notable that on the semantic differential scale "gives right answers-gives wrong answers," although twice as many Non-CAI as CAI students appeared to be undecided (30% of the Non-CAI group vs. 14% of the CAI group), a sizeable proportion from each group (80% of the CAI group vs. 68% of the Non-CAI group) recorded a preference for the left side of the scale. Moreover, 72% of the former group and 61% of the

TABLE 6

"Expertise" of Computer as Source of Information
(Distributions and Means for CAI and Non-CAI Groups)

	Items	Sample Groups	Percent Distributions 1	2	3	4	5	%"No Opinion"	$\bar{X}$	t^a
1.	Gives right answers-Gives wrong answers.	CAI	72	8	14	0	6		1.60	0.790
		Non-CAI	61	7	30	1	1		1.73	
			Strongly Agree	Agree	Disagree	Strongly Disagree				
2.	A computer can answer almost all your questions.	CAI	20	56	10	14		18	2.19	-0.283
		Non-CAI	18	55	20	7		33	2.15	
3.	I believe a computer will always be right.	CAI	27	41	25	7		12	2.11	1.804
		Non-CAI	16	34	44	6		36	2.40	
4.	Computers are smarter than people.	CAI	15	50	15	20		20	2.40	0.904
		Non-CAI	20	25	34	22		33	2.58	
5.	Computers are smarter than textbooks.	CAI	24	61	7	7		18	1.97	-0.361
		Non-CAI	27	58	11	4		33	1.92	
			None	Some	Much	Very Much				
6.	How much information does a computer have?	CAI	6	15	17	62		4	3.35	1.976*
		Non-CAI	1	7	18	74		40	3.64	
			Never	Sometimes	Usually	Always				
7.	How often do you disagree with what a computer says?	CAI	63	23	6	8		4	1.60	-1.346
		Non-CAI	70	16	5	3		73	1.35	
8.	How often does a computer make a mistake?	CAI	56	33	11	0		10	1.55	0.000
		Non-CAI	50	44	6	0		48	1.55	

[a]Two-tailed t

* = $p < .05$

latter marked the extreme left position of the scale, suggesting a firm belief that the computer gives right answers.

On the items "A computer can answer almost all your questions" and "Computers are smarter than textbooks," agreement (strong or moderate) was recorded by a clear majority of both CAI and Non-CAI students. In contrast, on the items "I believe a computer will always be right" and "Computers are smarter than people," Non-CAI students were clearly divided in their expression of agreement and disagreement, and the tendency to agree rather than disagree with these statements was apparent (but not pronounced) only for the CAI group. In other words, a sizeable minority of the CAI group and half the Non-CAI group rejected the idea of computer superiority over people in terms of "smartness" as well as that of computer infallibility. While it is difficult to clarify the meaning of disagreement with the first[6] of these assertions, disagreement with the idea of the computer being always right should probably be understood in connection with responses to the item dealing with the frequency of computer mistakes. On this item, 44% of the CAI group and 50% of the Non-CAI group appeared to expect the computer to make mistakes "sometimes" (CAI: 33%; Non-CAI: 44%) or "usually" (CAI: 11%; Non-CAI: 6%); the remaining 56% of the CAI group and 50% of the Non-CAI group responded "never." In other words, while a clear-cut majority of these students attributed to the computer considerable expertise, nearly half refused to identify expertise with infallibility, and stressed their awareness that the computer is capable of making mistakes.[7]

---

[6]It is not clear whether disagreement with the statement "Computers are smarter than people" refers to its specific content (meaning that computers are not smarter than people), or implies rejection of the idea of comparing people and computers in terms of smartness.

[7]It is possible that by computer mistakes many students meant failures of the system hardware, since 52% of the CAI group and 68% of the Non-CAI group indicated that they expect the computer to break down "sometimes." The findings on this item are discussed in more detail in a subsequent section.

2. Trustworthiness

"At the computer you learn more, because it tells you it's wrong and you just keep doing it until it tells you you're right."

"It shows the answers and your mistakes, and you can see how ... what you do wrong."

"[Since I started working at the computer] I am getting better grades ... Things we have ... they seem easier to me ... like problems that I didn't know how to do now I know how to do. By mistakes ... it corrects me and shows what I'm doing wrong."

"You learn more ... the computer sometimes gives you the same problem twice ... and when you get it wrong the first time, the second time you can get it right."

(Interview excerpts)

Most of the questionnaire items grouped under trustworthiness focus on the machine-learner interaction. Intercorrelations among the items (see Table 7) suggest that they tap a common dimension of the students' image of the computer. This sense of trust is based not so much on the correctness of the information transmitted as on the way in which the interaction between the learner and the machine takes place. In other words, the focus is on the interaction process rather than the content of the program. For example, perception of the computer as "giving enough time to answer a question," and as "telling if the response is right or wrong," as well as "satisfaction with having the computer choose which problems to give," "liking for doing math problems with the computer," and "preference for learning math from a computer" were all significantly associated with perception of the computer as "fair" (See Table 7, Column 1). The coefficients involved reached significance levels only for the CAI group, a finding which suggests that experience with CAI makes for more cohesion of attitude toward the computer as a monitor of a learning situation. In other words, this more definite sense of "trustworthiness" in essence may be a reflection of the students' feeling that involvement in the learning situation created by a CAI program helps them fulfill specific expectancies associated with the attainment of a more general goal, such as learning mathematics.

TABLE 7

Correlations Among "Trustworthiness of Computer" Items For CAI and Non-CAI Groups[a]

Items	Sample Groups	1	2	3	4	5	6	7	8
1. S.D. Scale "Fair-Unfair"	CAI	1.00							
	Non-CAI	1.00							
2. How often does a computer give you enough time to answer a question?	CAI	-.31*	1.00						
	Non-CAI	-.28	1.00						
3. When the computer gives you math problems to do, how often do you understand what you are supposed to do?	CAI	-.24	.26	1.00					
	Non-CAI	.02	.20	1.00					
4. Are you happy with having the computer choose which math problems to give you?	CAI	-.33*	.39**	.47***	1.00				
	Non-CAI	-.20	.48*	.26	1.00				
5. When you have done a math problem, does the computer tell you if you are right or wrong?	CAI	-.37**	.36*	.29*	.41**	1.00			
	Non-CAI	-.16	.41*	.42*	.54**	1.00			
6. Do you like doing math problems with the computer?	CAI	-.51***	.25	.28*	.39**	.44***	1.00		
	Non-CAI	-.02	.54**	.15	.41**	.53***	1.00		
7. I would prefer to learn math from a computer.	CAI	.45***	.37**	-.26	-.31*	-.37**	-.46***	1.00	
	Non-CAI	.19	-.08	-.41**	-.17	.02	-.28**	1.00	
8. Are you happy with the scores the computer gives you on math problems?	CAI	-.23	.39**	.17	.17	.28*	.28*	-.43***	1.00
	Non-CAI	.16	.49*	.24	.69***	.56**	.63***	.14	1.00

[a]The sign of r's reflects the direction of the scale. See questionnaire (Appendix 1).

* = $p < .05$

** = $p < .01$

*** = $p < .001$

Further inspection of the correlational matrix suggests that the three central characteristics which seem to make up the trustworthiness of the learning situation experienced by the students are the clarity of the message (When the computer gives you math problems to do, how often do you understand what you are supposed to do?), the time allowed for the performance of each specific task (How often does a computer give you enough time to answer a question?), and the availability of immediate feedback (When you have done a math problem, does the computer tell you if you are right or wrong?).

The level of responses to these items (see Table 8) indicates that students do have confidence in the interactive features of the CAI program. A second feature is that experience with CAI greatly affected the proportions of "No opinion" responders within each group. On five of the eight items listed in Table 8, the proportions of Non-CAI "Don't know" responders and nonresponders were greater than 50%. Those students without experience with CAI who did respond appeared to have an over optimistic or unrealistic view of the trustworthiness of the learning situation: They tended to overestimate the amount of time provided by the CAI program and to underestimate the degree of satisfaction that would come from experience with CAI. This higher level of satisfaction with the computer is also expressed in the greater preference of CAI students for the computer as a medium of instruction in mathematics.

In summary, experience with CAI consolidates and strengthens students' views of the computer as trustworthy. A central aspect of this image is that the computer gives immediate feedback about the quality of the student's performance on assigned problems. Both CAI and Non-CAI students were aware of this feature of the program.

3. Charisma - Personalization

> "Like brain machine ... you want to know, you stick a slot, you ask it, it will answer back to you."

> "[In scoutorama] there's somebody in [the computer] ... you put your name there and everything ... put down a question and put it on it through a slot, and the guy inside reads it and then he gets papers on that ... slips it out the other end."

TABLE 8

"Trustworthiness" of Computer
(Distributions and Means for CAI and Non-CAI Groups)

Items	Sample Groups	Percent Distributions 1	2	3	4	5	%"No Opinion"	$\bar{X}$	t^a
1. S.D. Scale: Fair-Unfair	CAI	56	18	10	6	10		1.96	-.519
	Non-CAI	50	15	33	1	1		1.87	
		Never	Sometimes	Usually	Always				
2. How often does a computer give you enough time to answer a question?	CAI	27	47	18	9		10	2.09	2.001*
	Non-CAI	23	23	27	27		78	2.57	
3. When a computer gives you math probs. to do, how often do you understand what you are supposed to do?	CAI	4	40	38	17		6	2.68	-1.653
	Non-CAI	13	40	40	6		66	2.40	
4. When you have done a math prob., does the computer tell you if you are right or wrong?	CAI	6	2	10	82		0	3.67	-1.626
	Non-CAI	7	14	12	67		59	3.30	
		No, not at all	Yes, some	Yes, Much	Yes, very much				
5. Are you happy with having the comp. choose which math probs. to give you?	CAI	15	50	13	22		8	2.41	-2.577**
	Non-CAI	31	54	10	5		71	1.90	
6. Do you like doing math probs. with the computer?	CAI	12	18	29	41		2	2.98	-1.025
	Non-CAI	6	36	29	28		39	2.80	
7. Are you happy with the scores the comp. gives you on math problems?	CAI	12	35	41	12		2	2.53	-0.143
	Non-CAI	17	33	33	17		78	2.50	
		Ranks 1	2	3	4				
8. I would prefer to learn math from a computer.	CAI	56	32	6	6		0	1.62	2.876***
	Non-CAI	37	28	24	11		0	2.10	

[a]Two-tailed t
* = $p < .05$
** = $p < .02$
*** = $p < .001$

"IBM works some ... like cards ... there are answers on it ... it tells people who are working with it ... answers about everybody's score on different schools and places and days ... I think, like ... police. I think they use them to ... to keep records of things."

"If he was programmed for only a certain thing, he would know only that certain thing, but if he was programmed for lots of things, he would know lots of things ... like one computer would only know to do math, but another computer might be able to do math, social studies, and English, and all that."

(Interview excerpts)

Observation of students working at computer terminals and interview material collected in the early stages of the study suggested the possibility that students might attribute to the computer qualities denoting a certain power which goes beyond the idea of expertise or trustworthiness. To investigate the possibility that students may attribute to the computer human-like, or even superhuman (charismatic) qualities -- such as the ability to bring about desirable effects within very short periods of time, limitless endurance in work (lack of fatigue or mechanical failure), infallibility, unpredictability, and unresponsiveness to external attempts for change -- specific items were included in the questionnaire (see Tables 9 and 10).

The matrix shown in Table 9 indicates that the items designed to convey the idea of charisma and personalization of the computer were interrelated to an extent which justifies the inference that they tap a specific dimension of the students' image of the computer. Of a total 28 coefficients for each group, 15 (53%) were significant for the CAI group and 8 (28%), for the Non-CAI group.

For both CAI and Non-CAI groups the computer has a charismatic quality. Inspection of the mean scores and distributions of responses of CAI and Non-CAI students on these items (see Table 10) indicates that a clear-cut majority of both groups recorded agreement (strong or moderate) with the statements "A computer never gets tired of working with you" and "A computer could help you improve your math grades in one month." Further, both groups appeared to agree rather than disagree with the statement "A computer sometimes acts like a person," although the

TABLE 9

Correlations Among Computer "Charisma-Personalization" Items for CAI and Non-CAI Groups[a]

Items	Sample Groups	1	2	3	4	5	6	7	8
1. A computer could help you improve your math grades in one month.	CAI	1.00							
	Non-CAI	1.00							
2. Computers are smarter than people.	CAI	.46**	1.00						
	Non-CAI	.02	1.00						
3. A computer sometimes acts like a person.	CAI	.30	.38*	1.00					
	Non-CAI	.11	.26*	1.00					
4. A computer never gets tired of working with you.	CAI	.21	-.19	-.07	1.00				
	Non-CAI	.03	.30**	-.09	1.00				
5. I believe a computer will always be right.	CAI	.16	.17	.35*	.07	1.00			
	Non-CAI	.37***	.25*	.21	.24*	1.00			
6. How often do you know what a computer is going to do next?	CAI	.38**	.28	.36*	-.05	.27	1.00		
	Non-CAI	.23	-.27*	.05	-.08	-.13	1.00		
7. If you wanted to change something in a computer's lesson do you think you could change it?	CAI	.15	.35*	.39**	-.35*	.32*	.34*	1.00	
	Non-CAI	.03	-.09	-.02	-.12	-.13	.21	1.00	
8. How often does a computer break down?	CAI	.35*	.23	-.07	.04	-.03	-.40**	.13	1.00
	Non-CAI	.11	-.22	-.29*	-.15	.21	-.17	.15	1.00

[a]The sign of r's reflects the direction of the scale. See questionnaire (Appendix 1).

* = $p < .05$
** = $p < .01$
*** = $p < .001$

tendency to agree was more pronounced among CAI than Non-CAI students. On the other hand, the statements "Computers are smarter than people" and "I believe a computer will always be right" elicited clearly split opinions from Non-CAI students, whereas CAI students recorded higher proportions of agreeing than disagreeing responses. However, on none of these items were CAI and Non-CAI group means significantly different, a finding which suggests that the tendency to perceive the computer as endowed with charismatic qualities is independent from experience with CAI. Viewed in conjunction with the fact that on these items, the proportion of "Don't know" responders and nonresponders in the Non-CAI group was relatively low,[8] these data lend additional support to the interpretation mentioned earlier that students come to CAI with certain preconceptions which either remain unaltered by their actual experience with the CAI program or are further strengthened.

Students feel that they have little power over the computer. Both CAI and Non-CAI students appeared to perceive the computer as unresponsive to eventual student attempts to bring about modification of the content or the format of the lessons it gives. In addition, both CAI and Non-CAI students appeared to regard the CAI program as unpredictable. Since responses to other questionnaire items have indicated that CAI students know from experience the format of the drill-and-practice lessons they receive, it may be the difficulty level of the lessons that they cannot predict. Whatever the specific meaning of responses to Item 5, it is notable that, for the CAI group, this item is significantly related to Item 7, which explores students' views of their ability to bring about change in a computer-administered lesson. Thus, the data from both these items suggest that the sense of control that CAI students experience over

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[8] Low proportions of "No opinion" Non-CAI students indicates that the means shown for the Non-CAI group are based on N's large enough to be relatively safely comparable to those obtained from the CAI group. The modal response for the Non-CAI group is not "Don't know" or no response, as was true on other items.

TABLE 10

"Charisma-Personalization" of Computer
(Distributions and Means for CAI and Non-CAI Groups)

Items	Sample Groups	Percent Distributions 1	2	3	4	%"No Opinion"	$\bar{X}$	t^a
		Strongly Agree	Agree	Disagree	Strongly Disagree			
1. A computer could help you improve your math grades in one month.	CAI	24	52	14	10	16	2.09	0.116
	Non-CAI	22	52	20	6	43	2.11	
2. Computers are smarter than people.	CAI	15	50	15	20	20	2.40	0.904
	Non-CAI	20	25	34	22	33	2.58	
3. A computer sometimes acts like a person.	CAI	19	52	17	12	16	2.21	1.453
	Non-CAI	10	49	29	13	39	2.45	
4. A computer never gets tired of working with you.	CAI	37	48	11	4	8	1.83	-0.034
	Non-CAI	32	57	7	4	39	1.82	
5. I believe a computer will always be right.	CAI	27	41	25	7	12	2.11	1.804
	Non-CAI	16	34	44	6	36	2.40	
		Never	Sometimes	Usually	Always			
6. How often do you know what a computer is going to do next?	CAI	65	25	10	0	4	1.46	-2.111*
	Non-CAI	87	8	1	3	50	1.20	
7. If you wanted to change something in a computer's lesson, do you think you can change it?	CAI	76	20	0	4	10	1.33	1.115
	Non-CAI	68	19	7	6	50	1.51	
8. How often does a computer break down?	CAI	2	52	28	18	0	2.62	-2.821**
	Non-CAI	9	68	15	8	53	2.21	

[a]Two-tailed t.
* = $p < .05$
** = $p < .01$

the computer-monitored learning situation is very low. Furthermore, the direction of correlations between each of these efficacy items and the items exploring the tendency to attribute to the computer charismatic qualities indicates that the lower the student's sense of efficacy over the computer the higher the likelihood that he will regard it as possessing charismatic powers (see Table 9).

This association between the CAI students' view of the computer as having charisma and their sense of low control over computer-monitored learning situations is an important finding because of its potential for establishing a dependency relationship. Of course, at this stage causality between the two cannot be inferred. Exploration of possible contingent relationships between viewing the computer as charismatic and a sense of low efficacy over teacher-monitored learning situations may help shed additional light on the issue.

Responses to the question, "How often does a computer break down?" indicate that both CAI and Non-CAI students have a quite realistic view of the technical efficiency of the machine. Only 2% of the CAI group (and 9% of the Non-CAI group) responded "never," while 52% of the former, and 68% of the latter group marked the alternative "sometimes." The difference between the mean scores of the two groups on this item indicates that Non-CAI students, compared to their CAI peers, had a higher regard for the technical efficiency of the machine (see Table 10). It is notable that for the CAI group, this item was negatively related to the item inquiring about predictability of the program ($r = -.40$, significant at the .01 level) and positively related to the item inquiring about the extent to which the computer makes mistakes ($r = .43$, significant at the .01 level). Apparently, for some CAI students perception of the CAI program as unpredictable and/or prone to errors is associated with experiences of failures of the computer hardware.

The Computer and Other Sources of Socialization

A basic hypothesis of this study was that the introduction of CAI in the school would affect the students' perception of, and attitudes toward, other agents of socialization. To the extent that the computer provides a valid alternative to traditional learning situations, it might be seen as more desirable. Thus, a comparison of the child's evaluative perception of the computer with traditional sources of instruction (e.g., teacher, textbook, etc.) is an important way of exploring the impact of CAI on the educational ecology.

The results reported in this section involve comparisons between the computer and the teacher, textbook, and television news. They focus on the general image of these sources of socialization, as reflected on the semantic differential. Teacher and computer will also be compared along the dimensions of expertise, trustworthiness and charisma.

The image of the computer and the teacher. Students hold a more favorable image of the computer than of the teacher. This applies for both CAI and Non-CAI students (see Figure 2 and Table 11). For the CAI group, significant mean differences indicate that these students regard the computer as fairer, easier, clearer, bigger, more likable, and better than the teacher. On only one of the five scales (see p. 16) comprising the evaluation dimension (the scale "gives right answers-gives wrong answers") was the mean difference between computer and teacher nonsignificant for the CAI group. And on this scale the direction of the difference was the same as on the other scales: the computer appeared more likely to give right answers than the teacher. For the Non-CAI group, mean differences were significant on nine of the ten scales (the exception was the scale "big-small"), and larger than for the CAI group, indicating that these students had an even more favorable view of the computer as compared to the teacher. However, as can be seen in Figure 2, the actual difference between CAI and Non-CAI students was in their image of the teacher rather than the computer; the latter group held a clearly less favorable image of the teacher than did the former, while there was practically no difference between the two groups in terms of their ratings of the computer.

It is difficult to argue that, for the CAI group, the image of the teacher was favorably influenced by their experience with CAI, although this is possible. If experience with the drill-and-practice program actually helped them gain in competence, the fact that they were selected by the teacher may make them feel more positive toward him. Further evidence is needed, of course, to clarify this question.

TABLE 11

Image of Computer and Teacher: Semantic Differential
(Means for CAI and Non-CAI Groups)

Scale	CAI Computer $\bar{X}$	CAI Teacher $\bar{X}$	t^a	Non-CAI Computer $\bar{X}$	Non-CAI Teacher $\bar{X}$	t^a
Soft - Hard	3.23	3.76	1.69	3.36	4.01	4.08**
Fast - Slow	1.88	2.35	1.49	1.96	2.72	4.86**
Right - Wrong Answers	1.60	1.89	0.85	1.73	2.08	2.73**
Fair - Unfair	1.96	2.74	2.39*	1.87	3.15	8.30**
Good - Bad	1.90	2.70	2.66*	2.09	3.05	5.43**
Warm - Cold	3.06	3.21	0.64	3.08	3.47	2.42*
Like - Dislike	2.02	2.86	4.03**	2.41	3.28	5.77**
Clear - Confusing	2.64	3.21	2.08*	2.68	3.46	4.36**
Big Small	3.14	2.23	-3.16**	2.27	2.31	0.62
Easy - Difficult	2.58	3.26	2.35*	2.69	3.48	4.57**

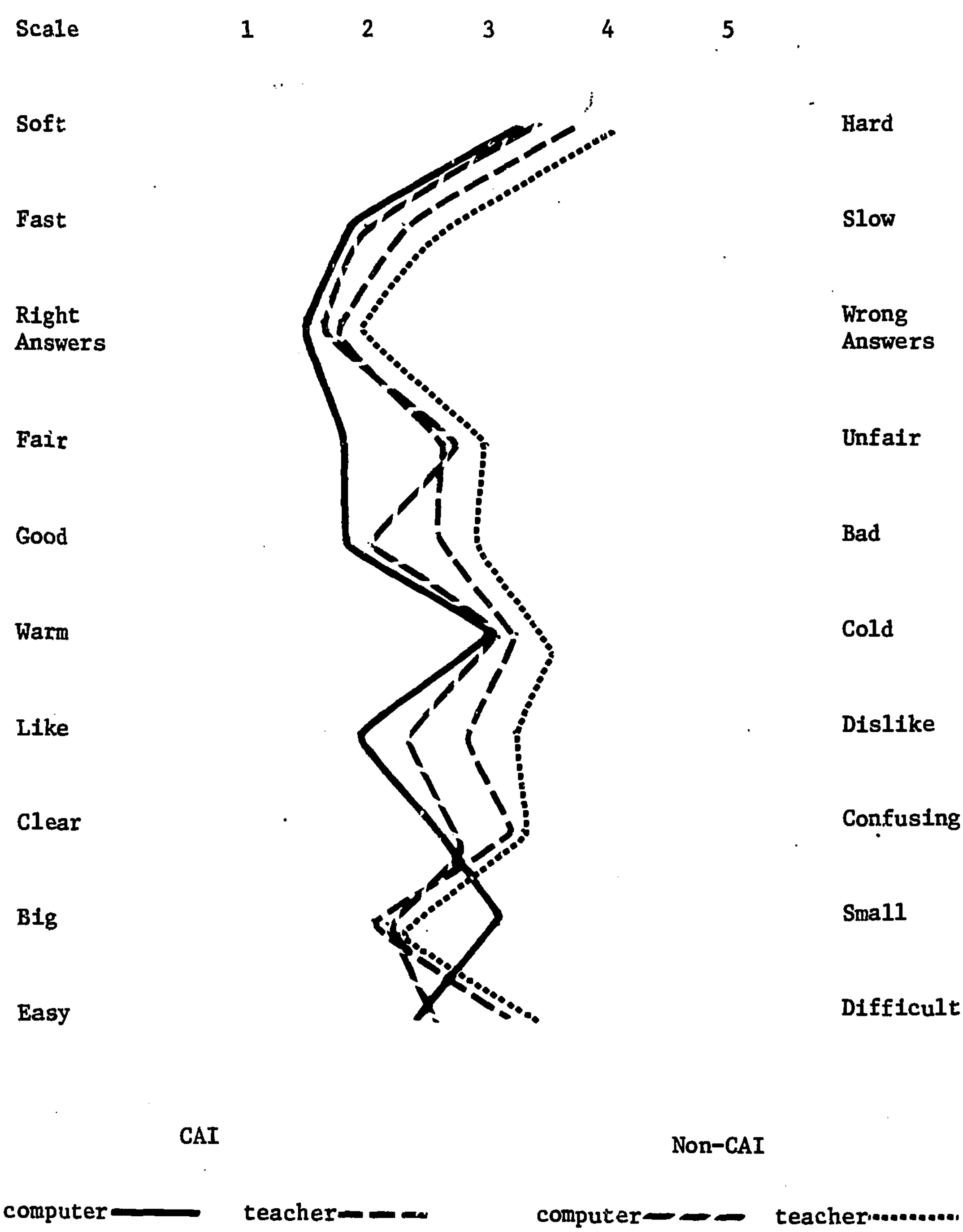
[a]Two-tailed t

* = $p < .05$
** = $p < .01$

<u>Image of the computer and other non-human sources of information.</u> Students have a more favorable image of the computer than of the textbook or T.V. news. Data from the semantic differential show that the mean scores pertaining to the computer differed significantly from those pertaining to the textbook and T.V. news for both CAI and Non-CAI groups (see Table 12). Compared to the textbook, the computer appears to be

FIGURE 2

Images of Computer and Teacher
(CAI and Non-CAI Groups)



regarded by CAI students as softer, faster, more likely to give right answers, more likable, clearer, and easier. Compared to T.V. news, the computer was also rated as faster, more likely to give right answers, and more likable. Mean differences for the Non-CAI group indicate that these students regarded the computer as faster, more likely to give right answers, fairer, more likable and bigger than the textbook, and as faster, fairer, and more likely to give right answers than T.V. news.

Both groups (CAI and Non-CAI) rated the computer more favorably than both other media of information dissemination on the validity or accuracy of information transmitted, suggesting that a major source of the socializing potential of this new medium of instruction is associated with the confidence it inspires about its expertise. The fact that both groups (CAI and Non-CAI) also regarded the computer as faster than the textbook and T.V. news, may be an indication that speed is also an important dimension of an effective medium of information processing and dissemination. Perhaps awareness of the computer's rapid information processing contributes to its more positive image compared to other media of information processing and dissemination; speed may be an additional element in the image of computer expertise.

Expertise, trustworthiness, and charisma of computer and teacher.

"The computer ... it don't got no feelings, it's just straight. The teacher, he will give you chances; they will work on you more."

"The computer doesn't explain any. The teacher would talk to me and see if you're trying or not."

"Sometimes the teacher grades you on your conduct and[although] you're not doing anything ... he still ..."

"The computer is not prejudiced like teachers are ... some teachers are."

"The computer shows the answers and your mistakes, and you could see how ... what you do wrong."

"The computer ... has all that information, combining information of lots of people, I guess. The teacher can forget all that and may not be right some of the time."

TABLE 12

Image of Computer, Textbook, and T.V. News: Semantic Differential (Means for CAI and Non-CAI Groups)

	Computer $\bar{X}$	Text-book $\bar{X}$		Computer $\bar{X}$	TV News $\bar{X}$	t^a
			CAI GROUP			
Soft - Hard	3.23	3.78	2.04*	3.23	3.00	-0.78
Fast - Slow	1.88	2.88	4.23**	1.88	2.92	4.20**
Right - Wrong Answers	1.60	2.06	2.21*	1.60	2.24	2.48*
Fair - Unfair	1.96	1.92	-0.16	1.96	2.14	0.69
Good - Bad	1.90	2.30	1.67	1.90	2.26	1.42
Warm - Cold	3.06	3.21	0.52	3.06	2.98	-0.29
Like - Dislike	2.02	3.00	4.16**	2.02	2.54	2.08*
Clear - Confusing	1.64	3.28	2.45*	1.64	2.56	0.25
Big - Small	3.14	3.56	1.43	3.14	2.60	1.75
Easy - Difficult	2.58	3.56	3.08**	2.58	2.84	1.12
			NON-CAI GROUP			
Soft - Hard	3.36	3.67	1.72	3.36	3.32	0.76
Fast - Slow	1.96	3.07	7.33**	1.96	2.51	3.83**
Right - Wrong Answers	1.73	2.08	3.10**	1.73	2.28	4.54**
Fair - Unfair	1.87	2.39	3.84**	1.87	2.16	2.87**
Good - Bad	2.09	2.36	1.27	2.09	2.22	0.31
Warm - Cold	3.08	3.23	0.66	3.08	3.12	0.25
Like - Dislike	2.41	2.89	3.49**	2.41	2.61	1.65
Clear - Confusing	2.68	3.02	1.42	2.68	2.65	0.60
Big - Small	2.27	3.39	7.46**	2.27	2.40	1.43
Easy - Difficult	2.69	2.89	0.81	2.69	2.85	0.81

[a]Two-tailed t.
* = $p < .05$
** = $p < .01$

"The computer, I think, knows more than a teacher."

(Interview excerpts)

On all items conveying the idea of expertise the computer was rated more favorably than the teacher. As shown in Table 13, the mean scores pertaining to computer and teacher differed significantly for both CAI and Non-CAI groups. Thus, the computer was perceived as having more information than the teacher, and as making mistakes less often than the teacher. Also, students appeared to expect to disagree less often with a computer's than a teacher's statements. Furthermore, on the items dealing with infallibility and capability to answer most questions, the tendency to agree (strongly or moderately) was greater in reference to the computer than the teacher. Finally, on the semantic differential scale "gives right answers-gives wrong answers," both groups rated the computer more favorably than the teacher, though the difference in means reached significance level only for the Non-CAI group.

On the items used to tap trustworthiness there was also a clear trend of student favorableness toward the computer as compared to the teacher. Table 14 shows that the mean scores pertaining to computer and teacher differed significantly on seven of the eight items for the CAI group, and on three items for the Non-CAI group.

More specifically, both groups' ratings indicate that the computer is regarded as fairer than the teacher, and as more often giving feedback about the correctness or wrongness of results produced by students on specific tasks. Also, both groups indicated more liking for performing tasks related to mathematics at the computer console than in class with the teacher.

On the other hand, only CAI students showed a higher regard for the intelligibility of computer messages as compared to teacher messages (Item 3). Also, only CAI students appeared to discriminate between computer and teacher performance of the functions of assigning and evaluating tasks related to mathematics: to these students, the computer appeared to assume both these functions more satisfactorily than the teacher. Finally, preference for the computer rather than the teacher as a source of instruction in mathematics was clear-cut for the CAI group, whereas Non-CAI students were divided in the expression of their preferences between the two.

TABLE 13

"Expertise" of Computer and Teacher
(Means for CAI and Non-CAI Groups)

Items	CAI Computer $\bar{X}$	CAI Teacher $\bar{X}$	t^a	Non-CAI Computer $\bar{X}$	Non-CAI Teacher $\bar{X}$	t^a
1. Gives right answers-Gives wrong answers.	1.60	1.89	0.85	1.73	2.08	2.73**
2. A computer (teacher) can answer almost all your questions.	2.25	2.75	2.31*	2.15	2.55	3.40***
3. I believe a computer (teacher) will always be right.	2.02	3.20	6.52***	2.41	3.08	6.16***
4. How much information does a computer (teacher) have?	3.33	2.71	-3.04**	3.61	2.67	-8.46***
5. How often do you disagree with that a computer (teacher) says?	1.60	2.67	5.32***	1.37	2.26	4.87***
6. How often does a computer (teacher) make a mistake?	1.55	2.14	4.09***	1.56	2.37	6.87***

[a]Two-tailed t.
* = $p < .05$
** = $p < .01$
*** = $p < .001$

TABLE 14

"Trustworthiness" of Computer and Teacher
(Means for CAI and Non-CAI Groups)

Items	CAI Computer $\bar{X}$	CAI Teacher $\bar{X}$	t^a	Non-CAI Computer $\bar{X}$	Non-CAI Teacher $\bar{X}$	t^a
1. Fair-Unfair	1.96	2.74	2.39*	1.87	3.15	8.30***
2. How often does a computer (teacher) give you enough time to answer a question?	2.09	1.95	-0.70	2.61	2.19	-1.57
3. When a computer (teacher) gives you a math problem to do, how often do you understand what you are supposed to do?	2.68	2.14	-3.22**	2.40	2.25	-0.88
4. When you have done a math problem does the computer (teacher) tell you if you are right or wrong?	3.67	2.16	-8.35***	3.43	2.36	-5.64***
5. Are you happy with having the computer (teacher) choose which math problems to give you?	2.44	1.69	-3.61***	1.87	1.79	-0.39
6. Do you like doing math problems with the computer (teacher)?	3.00	1.81	-5.75***	2.82	2.01	-5.54***
7. Are you happy with the scores the computer (teacher) gives you on math problems?	2.51	1.94	-3.04**	2.52	2.24	-1.09
8. I would prefer to learn math from a computer (teacher).	1.62	2.23	3.11**	2.11	1.95	-1.25

[a]Two-tailed t.
* = $p < .05$
** = $p < .01$
*** = $p < .001$

A last point in the data shown in Table 14 which deserves attention is that neither group appeared to discriminate between computer and teacher in terms of giving students enough time to answer a question. The finding is important, especially for the CAI group, because the drill-and-practice program on which these students were working allows a limited amount of time for the performance of each specific task. Apparently, CAI students did not feel that the time limits built into the CAI program for the execution of arithmetic operations are more or less restricted than those set by the teacher for the performance of math problems in the class.

To conclude, the greater confidence demonstrated toward the computer as compared to the teacher appears to result from differences perceived by the student in the learning situation in which he finds himself when he works at the computer terminal and in class with the teacher; for the CAI student in particular, the feeling that the situation managed via computer is more likable and fairer than that monitored by the teacher seemed to be contingent upon the experience that the CAI program gives him messages which he understands, and on the fact (of which both groups seemed to be aware) that it also provides immediate (and factual) feed-back on the quality of his performance of the tasks it assigns.

The last group of items allowing comparisons between teacher and computer refers to the idea of charisma. Data on these items also indicate that both CAI and Non-CAI students are more inclined to attribute charismatic qualities to the computer than to the teacher (see Table 15). Thus, properties such as limitless endurance in work (indefatigability), infallibility, and the capability to help a student "improve his math grades in one month" were more readily ascribed to the computer than the teacher by both CAI and Non-CAI students.

However, CAI and Non-CAI students differed in their respective views about the degree of predictability of a teacher's course of action as compared to that of a CAI program, and about the extent to which teacher and computer are responsive to student attempts to change "something" (e.g., the content or the format) in the lessons they give. The CAI students' means on these two items indicate no significant difference between computer and teacher predictability (i.e., the teacher was not perceived as more predictable than the computer), but a greater confidence in the teacher's responsiveness to external (student) attempts to bring about change in his lessons. In contrast, Non-CAI students appeared to regard the teacher's course of action as more predictable than that of the CAI program, but saw no difference between teacher and computer responsiveness to student attempts to change their lessons: both computer and teacher were rated as almost equally unresponsive to such attempts.

What is the significance of these findings? It should be noted that the variables of predictability and responsiveness were positively and significantly associated for the CAI group, whether applied to the teacher or the computer. For the Non-CAI group, a significant positive relationship between predictability and responsiveness was found only when these variables referred to the teacher. Since only the CAI students' views reflect experience with both teacher and computer, their perception of both situations as unpredictable reflects a generalized sense of inefficacy and "externality" of the locus of control (Rotter, 1966). If this is true, the view of the computer as relatively unresponsive may be an additional indication of a sense of low internal control.

Experience with CAI, however, may help the student become aware that the computer is actually less responsive to the students' desires to bring about change in the course or in the content of a lesson. This is particularly true for the linear program with which CAI students were familiar. Therefore, the greater responsiveness attributed to the teacher by CAI students may represent an indication that CAI experience helps these students to gain a realistic view of some of the limitations as well as the capabilities of both their teachers and CAI.

Viewed in conjunction with the similarities on the semantic differential between CAI and Non-CAI students in their ratings of the computer, and the more favorable image of the teacher held by the former group, this finding suggests that experience with CAI may have beneficial effects on the total socializing experience provided by the school. As an alter-

TABLE 15

"Charisma" of Computer and Teacher
(Means for CAI and Non-CAI Groups)

Items	CAI Computer $\bar{X}$	CAI Teacher $\bar{X}$	t^a	Non-CAI Computer $\bar{X}$	Non-CAI Teacher $\bar{X}$	t^a
1. A computer (teacher) could help you improve your math grades in one month.	2.11	2.66	2.44*	2.08	2.43	2.37*
2. A computer (teacher) never gets tired of working with you.	1.87	3.07	5.79***	1.81	3.26	13.47***
3. I believe a computer (teacher) will always be right.	2.02	3.20	6.52***	2.41	3.08	6.16***
4. How often do you know what a computer (teacher) is going to do next?	1.47	1.72	1.48	1.21	1.78	4.96***
5. If you wanted to change something in a computer's (teacher's) lesson, do you think you can change it?	1.34	1.89	2.93**	1.51	1.63	0.88

[a]Two-tailed t.
* = $p < .05$
** = $p < .01$
*** = $p < .001$

native to the students' power-dependence relationships with the teacher, experience with CAI may help students overcome some of the tensions involved in their relations with the teacher, and gain a better insight into the advantages and limitations of both sources of instruction.

Implications

The data indicate that the computer has a more favorable image than the teacher, textbook, or T.V. news in the eyes of both CAI and Non-CAI students. For both groups, the major elements of the favorable image of the computer were associated with the idea of greater expertise in processing and transmitting information. The feeling of greater trust in the learning situation managed via computer was especially evident in the data pertaining to the CAI group. On the other hand, while both groups tended to ascribe charismatic qualities to the computer rather than the teacher, CAI students were more aware than their Non-CAI peers of the computer's unresponsiveness to student attempts to change the course or the content of its lessons.

What are the implications of these favorable attitudes toward the computer? If it can be assumed that CAI will continue to be perfected -- in the sense of a wider variety and higher quality of programs available at a lower cost -- it is possible that many school districts will adopt some form of this new instructional medium for fairly widespread use throughout the system. One implication of the introduction of an alternative source of instruction is that students may tend, in a free-choice situation, to choose the computer over the teacher.

In addition, the computer may become even more credible than the teacher in some areas. For example, the idea that the computer is likely to have more information than the teacher and is more likely to transmit it correctly and in a clear and comprehensive manner may lead students to discount the teacher's word even if there is not an open conflict in viewpoints. Students generally know that the teacher is not infallible; with an available comparison, this feeling may become exaggerated.

Such an alteration in the students' perception of the authority structure of the school does not necessarily mean that the teacher will have to spend his time in attempting to reestablish his power and status as expert. Rather, it implies a shift in functions and role of the teacher. Since the computer will have the capacity to act as an individual tutor to each student working with it on the perfection of micro-level skills (arithmetic, reading, basic knowledge of a subject area, etc.), it becomes the teacher's role to act as a synthesizer, a catalyst for new ways of organizing information and ideas and a leader in group work. In addition, the teacher can spend much more time on the affective components of learning, bringing subjects such as social studies into the students' frame of reference. Freed from teaching much of the basic material, the teacher will have time to think creatively about education, and to take learning out of the classroom and into the community agencies, museums, factories, and natural settings.

In short, CAI offers a valuable opportunity to expand the definition of public education, and to enhance the professionalization of teaching. Quite naturally, there will have to be administrative changes in the occupation, such as allowing teachers more autonomy to try new approaches, positively evaluating them for successful attempts and providing critical feedback for unsuccessful efforts. Thus, the opportunity which computer-assisted instruction provides is more than just an opportunity -- it imposes on teachers the responsibility to restructure both the classroom and their role in order to accommodate this new component in the educational ecology.

The Computer as an Authority Figure

In the section on theoretical and conceptual context, it was argued that an important dimension of the computer's potential to socialize lies in the fact that it is an effective instrument for monitoring student behavior. As a component of the authority structure of the school organization, the computer's monitoring of the students' goal-oriented behavior, like that of the teacher, is subject to a system of norms or beliefs held by other participants. Following sociological theories developed to study the functioning of formal organizations (Emerson, 1962; Scott et al., 1967; Dornbusch & Scott, in press), this section explores the possibility that experience with CAI may generate a power-dependence exchange between the student and the computer which could function concurrently with the teacher-student relationship; this might modify the students' perception of the authority structure of the school.

<u>Comparisons between computer and teacher as components of the school authority structure</u>. Organizational sociologists (Scott et al., 1967; Dornbusch & Scott, in press) have identified several <u>sources of</u> legitimation of the exercise of power (resource capacity) by participants in organizations. They focus particular attention on (a) those superiors in the system whose rules or beliefs support the exercise of power (<u>authorization</u> process); and (b) those subordinates subject to, and whose beliefs support, the exercise of power (<u>endorsement</u> process). Scott and his colleagues argue that in any power-dependence relationship within an organization, task performance is the central process involving attempts to achieve control over member activities toward goal attainment. They define four components of this process (allocating a task, setting criteria for evaluation, sampling, and appraising task performance) which can be regarded as <u>authority rights</u> or functions that the participants may be seen as authorized (and endorsed) to assume.

With respect to CAI, this study makes the basic assumption that CAI's introduction and adoption in a school implies that there is a set of norms on the basis of which school officials extend authority to the computer to exercise authority functions to control students' behavior toward goal attainment. To study the attitudes of students toward CAI, items were devised (a) to establish whether students perceive the computer as having certain functions or rights to exercise control over them; (b) to determine which functions they perceive the computer as exercising (validity measures); and (c) to obtain their estimates of the legitimacy of these functions or rights in terms of authorization (whether they perceive them as supported by higher school authorities), endorsement (whether they perceive them as supported by other students), and propriety (whether they themselves consider these functions as appropriate).

<u>Authority rights</u>. In this section of the study the central question was whether students perceived the computer and the teacher as exercising authority rights or functions over them. Students see the computer as exercising its power over them in task-specific areas in a pattern

similar to that of the traditional authority figure, the teacher. Items designed to explore the students' views on this point are presented in Table 18.

Justification for distinguishing theoretically between task-specific and nontask-specific rights or functions is indicated both by item intercorrelations found in Tables 16 and 17 and by factor analysis.[9] The proportion of significant positive coefficients for task-specific items is greater than chance for both teacher and computer. Task-specific and nontask-specific authority rights items are generally uncorrelated. If there is any tendency toward association at all, it is that task-specific items are negatively related to nontask-specific items for the computer. These data add some support for the distinction made between task-specific and nontask-specific authority rights for both the teacher and computer.

It was expected that students interacting with CAI would report that (a) the computer exercises task-specific authority rights over them to a degree similar to that of the teacher, and (b) the teacher's exercise of power more frequently includes nontask-specific authority rights, since the computer's exercise of power over students is not likely in nontask areas of concern. These expectations are supported by comparisons between teacher and computer on authority rights items (see Table 18). CAI students perceive both teacher and computer as exercising all six task-specific authority rights. The computer is perceived as exercising task-specific authority rights or functions as frequently, or more frequently, than the teacher in every case. Two of the mean comparisons indicate significant differences; that is, the computer "evaluates math performance" and "shows interest in the math work you do" significantly more often than does the teacher. The data in Table 18 indicate that the degree of the computer's task-specific authority is at least as great, and perhaps greater, than that of the teacher.

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[9] Task-specific authority rights and nontask-specific rights were found to be two separate orthogonal factors in the six-factor analysis performed for both teacher and computer items.

TABLE 16

Correlations Among Task-Specific and Nontask-Specific Authority Rights for Teacher (CAI Group)[a]

	1	2	3	4	5	6	7	8	9
<u>Task-Specific Authority Rights</u>									
Item: The math teacher...									
1. Chooses which math problems to give you.	1.00								
2. Checks your math problems.	.37*	1.00							
3. Helps you learn to do math problems.	.19	.32*	1.00						
4. Helps you get better math grades.	.35*	.33*	.46***	1.00					
5. Shows you how well or how poorly you are doing in math.	-.04	.17	.38**	.14	1.00				
6. Shows interest in the math work you do.	.19	.33*	.38**	.30*	.41**	1.00			
<u>Nontask-Specific Authority Rights</u>									
Item: The math teacher...									
7. Punishes you when you do something wrong.	.13	-.04	-.30*	-.27	-.17	-.17	1.00		
8. Gets impatient with you.	.34**	-.30	-.16	-.29	-.04	-.05	.32*	1.00	
9. Corrects your behavior.	.01	.26	.06	.03	-.03	.14	.27	-.07	1.00

[a]The sign of r's reflects the direction of the scale. See questionnaire (Appendix I).

* = $p < .05$
** = $p < .01$
*** = $p < .001$

TABLE 17

Correlations Among Task-Specific and Nontask Authority Rights for Computer (CAI Group)[a]

	1	2	3	4	5	6	7	8	9
<u>Task-Specific Authority Rights</u>									
Item: The computer...									
1. Chooses which math problems to give you.	1.00								
2. Checks your math problems.	.03	1.00							
3. Helps you learn to do math problems.	.48***	.11	1.00						
4. Helps you get better math grades.	.31*	.31*	.45**	1.00					
5. Shows how well or how poorly you are doing on math problems.	.12	.03	.38**	.37*	1.00				
6. Shows interest in the math work you do.	.16	-.07	.16	.16	.16	1.00			
<u>Nontask-Specific Authority Rights</u>									
Item: The computer...									
7. Punishes you when you do something wrong.	-.09	.18	.16	-.21	-.20	-.21	1.00		
8. Gets impatient with you.	-.41**	-.29	-.49***	-.22	-.19	.03	.11	1.00	
9. Corrects your behavior.	-.19	-.30	-.21	-.32	-.34	.01	.30	.49**	1.00

[a]The sign of r's reflects the direction of the scale. See questionnaire (Appendix 1).

* = $p < .05$
** = $p < .01$
*** = $p < .001$

This trend is reversed for nontask-specific authority rights or functions. As expected, the computer, unlike the teacher, is not perceived as punishing, getting impatient, and correcting behavior. While this may limit the range of behavior over which the computer exercises authority, in task-related areas the computer has more validity and may also have more endorsement than the teacher. One of the implications of this type of analysis is that it begins to differentiate the relative areas of human and nonhuman authority in the classroom. This distinction between the things that are human and those that can be implemented by nonhuman teachers is of great importance for a theoretical analysis of teaching roles and for training programs for teachers working with educational technology.

Modes of assigning tasks. Another major question investigated in this section dealt with the students' views about the ways math assignments are handled by the teacher as compared with the computer. The items included were intended to inquire about (a) the styles of assigning or allocating tasks,[10] (b) the responsiveness of CAI and the teacher to students' attempts to change these assignments (efficacy), and (c) the students' satisfaction with the task allocation process (see Table 19); and (d) the students' views about the sources of control over the assignment of tasks in the specific CAI program (see Table 20).

In general, CAI students have a favorable view of the computer's way of assigning tasks. They reported that the computer's task allocations are more often intelligible and less often too difficult than are assignments made by the teacher. There were no significant differences in student perception of teacher and computer concerning how often enough time is given to perform an allocated task (see Table 19). This finding is interesting in light of the fact that the computer program imposes a time limit on every task.

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[10]These items may also be thought of as tapping task-specific power, since the ways in which an authority figure assigns tasks may form important bases for student dependence upon that authority figure to attain goals.

TABLE 18

Comparisons Between Teacher and Computer on Authority Rights
(Means for CAI Group)

Items		Percent Distributions 1	2	3	Means	t[a]
a. Task-specific functions		Almost Never	Some-times	Usually		
1. The (T,C) chooses which math problems to give you.	Teacher	0	12	88	2.88	
	Computer	0	11	89	2.88	0.00
2. The (T,C) checks your math problems.	Teacher	2	13	85	2.83	
	Computer	2	10	88	2.85	-0.24
3. The (T,C) helps you learn to do math problems.	Teacher	10	23	67	2.55	
	Computer	4	19	77	2.72	-1.33
4. The (T,C) helps you get better math grades.	Teacher	15	35	50	2.37	
	Computer	7	33	61	2.53	-1.10
5. The (T,C) shows you how well or how poorly you are doing in math problems.	Teacher	20	41	39	2.20	
	Computer	8	21	71	2.61	-2.80**
6. The (,C) shows interest in the math work you do.	Teacher	28	46	26	1.90	
	Computer	7	37	56	2.49	-3.82***
b. Nontask-specific functions						
1. The (T,C)punishes you when you do something wrong.	Teacher	43	34	23	1.85	
	Computer	69	14	17	1.45	2.04*
2. The (T,C) gets impatient with you.	Teacher	16	49	35	2.14	
	Computer	55	30	15	1.56	3.27**
3. The (T,C) corrects your behavior.	Teacher	18	42	40	2.10	
	Computer	71	13	16	1.38	3.62**

[a]Two-tailed t.
* = p .05
** = p .01
*** = p .001

TABLE 19

Comparison Between Teacher and Computer
on Task Allocation Items
(Distributions and Means for CAI Group)

Items		Percent Distributions 1	2	3	4	Means	t[a]
Modes of Assigning Tasks		Never	Some-times	Usually	Always		
1. How often does the (T,C) give you enough time to answer a question?	Teacher	35	46	9	11	1.95	
	Computer	27	47	18	9	2.09	-0.70
2. How often does the (T,C) give you math problems which are too hard?	Teacher	10	52	23	15	2.43	
	Computer	14	67	16	2	2.06	2.26*
3. When a (T,C) gives you math problems to do, how often do you understand what you are supposed to do?	Teacher	20	51	24	4	2.14	
	Computer	4	40	38	17	2.68	-3.22**
Student Efficacy							
1. How often do you know what a (T,C) is going to do next?	Teacher	54	29	8	8	1.72	
	Computer	65	25	10	0	1.47	1.48
2. If you wanted to change something in a (T,C) lesson, do you think you could change it?	Teacher	39	47	2	12	1.89	
	Computer	76	20	0	4	1.34	2.93**
Satisfaction		No, not at all	Yes, some	Yes, much	Yes, very much		
1. Are you happy with having the (T,C) choose which math problems to give you?	Teacher	55	32	2	11	1.69	
	Computer	15	50	13	22	2.44	-3.61***

[a]Two-tailed t.

* = $p < .05$
** = $p < .01$
*** = $p < .001$

Although CAI students indicated that they can "sometimes" change something in the teacher's lesson, they appeared to feel less efficacious with respect to the computer; that is, a clear-cut majority of the CAI group (76%) reported that they are "never" able to change a computer's lesson (see Table 19). In addition, although the difference between means for teacher and computer predictability was nonsignificant, the trend was for the computer to be perceived as less predictable than the teacher. These measures suggest that CAI students experience a greater dependence on the computer's than the teacher's task-specific resources and authority. The measures of efficacy may reflect the previous finding that the degree of task-specific power or resource capacity attributed to the computer by CAI students is greater than that attributed to the teacher.

The data about student sense of efficacy over computer allocations can be further clarified by the students' views on the sources of control of task allocations in the specific CAI program they experienced (see Table 20). Forty percent of the CAI students appeared to think that the computer may determine its own allocations and 67% of them reported that it is their own previous performance which determines the content of the next computer allocation. However, since CAI performance is evaluated via computer, affirmative responses to these two alternatives may reflect a widespread feeling that it is in the students' own performance as evaluated by the machine that lies the main source of control over task allocations.[11] The proportions of affirmative responses to the remaining three alternatives (61% for "somebody at Stanford," 51% for "the computer supervisor," and 37% for "the math teacher") suggest that the majority of these CAI students see the sources of control of computer task allocations as being located outside of the math class. If, as Trow (1966) suggests, the status of the teacher in relation to technology is dependent on his ability to control that technology, this awareness on the part of the

[11]This idea is further substantiated by the fact that the item concerning student performance and its influence on subsequent computer allocations was negatively correlated with computer predictability (-.45) and responsiveness to students' attempts to change its lessons (-.32).

students of the teacher's lack of influence over CAI represents a shift in the students' perception of the authority structure of the school.

TABLE 20

Sources of Control of Computer Task Allocations
(CAI Group)

Item	%"Yes"
Which decides what math lessons you get from the computer:	
Response categories:	
The math teacher decides	37
Somebody at Stanford decides	61
The score I got the day before decides	67
The computer supervisor decides	51
The computer decides	40

CAI students also reported more satisfaction with having the computer rather than the teacher allocate their tasks (see Table 19). The distribution of responses to this item indicates that the mode is "yes, some" for the computer and "no, not at all" for the teacher.

Setting criteria for evaluation. What criteria do the computer and teacher use in evaluating performance in math? Five criteria were presented and students were asked to rate their importance from the point of view of the teacher and the computer. The relevant items are quoted in Tables 21 through 23. The proportion of significant correlations among these items was greater than chance for both teacher and computer, especially the former. Of a total ten coefficients for each authority figure, nine were significant (beyond the .05 level) for the teacher, and six for the computer (see Tables 21 and 22).

TABLE 21

Correlations Among Task-and Nontask-Specific Criteria of Evaluation for Teacher (CAI Group)

Item:	1	2	3	4	5
What does the teacher care about on the math work you do?					
Task-specific criteria					
1. How fast I do math problems	1.00				
2. If I get them right	.46**	1.00			
3. If I get them all done	.62***	.69***	1.00		
4. Having a neat paper	.69***	.58***	.59***	1.00	
Nontask-specific criteria					
5. Other things, such as coming in late, being absent, talking too much.	.34*	.38**	.38**	.10	1.00

* = $p < .05$
** = $p < .01$
*** = $p < .001$

TABLE 22

Correlations Among Task-and Nontask-Specific Criteria of Evaluation for Computer (CAI Group)

Item:	1	2	3	4	5
What does the computer care about on the math problems you do?					
Task-specific criteria					
1. How fast I do math problems	1.00				
2. If I get them right	.62***	1.00			
3. If I get them all done	.83***	.63***	1.00		
4. Having a neat paper	.52***	.37**	.56***	1.00	
Nontask-specific criteria					
5. Other things, such as coming in late, being absent, talking too much	.21	.17	.21	.23	1.00

* = $p < .05$
** = $p < .01$
*** = $p < .001$

Included in the cluster of these items is the distinction between task- and nontask-specific criteria of evaluation. It was expected that students would perceive the teacher as more likely than the computer to make evaluations of their task performance, at least in part, on the basis of nontask-specific criteria such as coming in late, being absent or talking too much. Unlike the computer's, the teacher's evaluations are not made for every task performance and are, therefore, more likely to be inferences based on either past performance indicators or nontask-specific criteria. Support for this notion is indicated in Tables 21 and 22, which show that while there are no significant correlations between task- and nontask-specific criteria for the computer, three (out of four) of the relevant coefficients pertaining to the teacher are significant beyond the .05 level. Further evidence supportive of such a distinction was provided by factor analysis of the questionnaire items [12] and by the data shown in Table 23.

TABLE 23

Comparisons Between Teacher and Computer Criteria of Task Evaluation (Distribution and Means for CAI Group)

Item:		Percent Distribution 1	2	3	4	$\bar{X}$	t^a
What does the (T,C) care about on the math problems you do?							
Task-specific criteria		No,not at all	Yes,a little	Yes Some	Yes, much		
1. How fast I do math problems	Teacher	20	18	36	27	2.69	
	Computer	13	6	17	64	3.32	-2.79**
2. If I get them right	Teacher	7	16	20	58	3.29	
	Computer	8	6	31	55	3.33	-0.19
3. If I get them all done	Teacher	11	7	26	57	3.28	
	Computer	13	6	19	62	3.30	-0.07
4. Having a neat paper	Teacher	14	14	25	47	3.04	
	Computer	34	11	17	38	2.60	1.79
Nontask-specific criteria							
1. Other things, such as coming in late, being absent, talking too much	Teacher	27	13	18	42	2.76	
	Computer	45	21	19	14	2.02	2.82**

[a] Two-tailed t.
** $p < .01$

[12] In a factor analysis of teacher items, task- and nontask-specific criteria formed one of the six orthogonal factors extracted. In the corresponding six-factor solution of computer items, only task-specific criteria formed one of the six orthogonal factors.

CAI students appeared to think that both teacher and computer base their evaluations of student performance primarily on the task-specific criteria of "speed," "correctness," "completeness," and then "neatness" (see Table 23). However, "speed" was thought to be the least important criterion for the teacher (less important than nontask-specific criteria), whereas nontask criteria and "having a neat paper" were the least important criteria for evaluations made by the computer. In other words, while there were no significant differences between teacher and computer on the alternatives denoting concern for "correctness," "completeness," and "neatness," in these students' view, "speed" is significantly more important for evaluations made by the computer than by the teacher, and "nontask-specific criteria" weigh significantly more in the teacher's than the computer's evaluations.

Evaluation of task performance. CAI students saw significant differences between teacher and computer in the ways they carry out the function of appraising task performance (see Table 24). For example, they believed that the computer evaluates their task performance more often than does the teacher. Further, although they were aware that the teacher's evaluations have a greater influence on grades than do the computer's evaluations, they saw no difference between teacher and computer evaluations in terms of degree of importance and reported more satisfaction with having their performance in math evaluated by the computer than by the teacher.

The finding that teacher evaluations were seen as having greater influence on grades reflects the fact that, in this school, evaluations of students' performance in CAI are not taken into consideration in the computation of their math grades. On the other hand, the finding that computer evaluations were rated to be as important as teacher evaluations apparently reflects the fact that the former provide immediate and factual information about the quality of the students' performance. In other words, computer evaluations appeared to be valued not only for their contribution to external rewards (grades) but also for the information they provide about the students' level of mastery over the tasks in question, which has intrinsic motivating power.

TABLE 24

Comparison Between Teacher and Computer Evaluation of Task Performance (for CAI Group)

Items:		Percentage Distribution 1	2	3	4	$\bar{X}$	t[a]
1. When you have done a math problem, does the (T,C) tell you if you are right or wrong?		Never	Sometimes	Usually	Always		
	Teacher	28	36	26	10	2.16	-8.35***
	Computer	6	2	10	82	3.67	
		No, not at all	Yes, a little	Yes, much	Yes, very much		
2. Do you think that the scores you get on math problems from the (T,C) change your math grade?	Teacher	19	21	30	30	2.67	2.58*
	Computer	50	17	11	22	2.02	
		Not at all	A little	Much	Very Much		
3. How much do you care about the scores the (T,C) gives you on math problems you do?	Teacher	9	4	19	68	3.46	.93
	Computer	6	12	31	51	3.26	
		No, not at all	Yes, a little	Yes, much	Yes, very much		
4. Are you happy with the scores the (T,C) gives you on math problems?	Teacher	40	36	13	11	1.94	-3.04**
	Computer	12	35	41	12	2.51	

[a]Two-tailed t.
* = $p < .05$
** = $p < .01$
*** = $p < .001$

<u>Consequences of poor task performance.</u> CAI students also believed that poor performance on tasks assigned by the teacher is more likely to evoke negative sanctions than is poor performance on tasks assigned via

computer (see Table 25). Comparison of the percentages of "yes" responses for teacher and computer indicates that CAI students believe that "poor grades," "teacher frowns," and the obligation to "stay after school" are more likely to follow poor performance on teacher-assigned than on computer-assigned tasks. Apparently, poor performance on computer-assigned tasks is less likely to be subject to informal teacher sanctions such as subtle nonverbal cues of disapproval, if for no other reason than that students work at the teletype on their own.

TABLE 25

Sanctions Following Poor Performance on Teacher-Assigned and Computer-Assigned Tasks: Percentages of "Yes" Responses (CAI Group)

Item: What can happen to students who do a poor job on math problems given by the (T,C)?	% "Yes" Teacher	Computer
They get poor grades	95	68
The teacher frowns at them	60	17
The teacher won't like them	33	20
They have to stay after school	53	7

These findings are congruent with previously reported data which suggested that the teacher, unlike the computer, exercises authority rights over nontask-specific areas of behavior, uses nontask-specific criteria for evaluation of task performance, and has little control over the allocation of computer tasks.

Measures of propriety, authorization, and endorsement. While several of the questionnaire items measured the degree of normative support for CAI, the items listed in Table 26 were included as specific measures of propriety, teacher authorization, and endorsement of the computer's monitoring of student performance in math. Data show that substantial normative support is accorded to CAI from all three sources of legitimation. No significant differences between the means on these items were found for the CAI group. These students consider the computer's exercise of power as appropriate, and also perceive their teachers and peers as being supportive of CAI.

Since the items referring to teacher authorization and peer endorsement of the role of the computer as a monitor of learning situations involving mathematics represent the respondents' views about these sources of legitimation, they may be regarded as simple replications of the item dealing with propriety, i.e., the respondent's own degree of acceptance of the exercise of such a role by the computer. In other words, many respondents may simply attribute to their peers and the teacher their own views about the legitimacy of the computer's role. If this is so, it is not surprising that there are no significant mean differences between these three items. However, teacher authorization was significantly lower than either propriety or endorsement (beyond the .025 level) for the combined population of CAI and Non-CAI students. This means that a number of students of both groups, but especially of the Non-CAI group, perceive their teachers as being somewhat less enthusiastic than students in general in their support of the computer's exercise of power.[13]

Comparing Computer and Teacher: Some Sociological Elaborations

Earlier in this section, comparisons between computer and teacher focused on parameters such as expertise, trustworthiness, and charisma attributed by the students to each of the two sources of authority. In this section the data have been grouped and examined following a specific sociological theory developed by Dornbusch and Scott (in press) with regard to the functioning of formal organizations. According to this

[13] It was reported earlier that the teacher was perceived by only 37% of the CAI group as deciding their computer allocations. This item was found to be negatively correlated with propriety (-.37) but positively correlated with teacher authorization (.31). This suggests that when the teacher is reported as not controlling computer allocations, having authority relations with the computer is supported by the students themselves but is not seen as authorized by the teacher.

theory, the process which most saliently involves both power-dependence relationships among participants and attempts to achieve control over members' activities toward goal attainment is task performance. It is the components of this process (i.e., allocating tasks, setting criteria for evaluation, sampling, or supervising task execution and appraising task performance) that reflect the style in which participants interact, i.e., exercise authority rights and/or respond to the exercise of such rights by other participants in the organization.

TABLE 26

Propriety, Teacher Authorization, and Endorsement of CAI[a]
(Distributions and Means for CAI Group)

Items	Percent Distributions 1 Less	2 Same	3 More	$\bar{X}$
1. If you could choose, would the computer score more, the same or less of your math problems?	22	33	44	2.22
2. If your math teacher could choose, would the computer score more, the same, or less of your math problems?	23	43	34	2.11
3. If your friends could choose, would the computer score more, the same, or less of their math problems?	16	36	48	2.32

[a]Two-tailed t's between Items 1 and 2 (.58), 2 and 3 (-1.12), and 1 and 3 (.52) were not significant.

According to Scott, Dornbusch, Bushing, and Laing (1967), "An authority right that is regularly exercised by one participant over another is termed an authority link between the two. The sum of all authority links connecting two participants constitutes, by definition, an authority relationship between the two. The constellation of all authority relationships of a participant, both with others over whom he exercises rights and with those who exercise rights over him with respect to a given task constitutes his authority system for that task."

In some organizational settings authority links concerning a given task are distributed among a number of participants; that is, authority rights may be exercised over a given individual by a variety of persons, each of whom may hold one or more of these rights. In mapping the authority systems of school students, only rights exercised over them were relevant, since students are, at least formally, the lowest status participants in the organization of the school.

In this section emphasis is given to pupil-teacher authority relations since, traditionally speaking, in the process of monitoring task performance, the teacher may be authorized to attempt control of student behavior in terms of all task relevant authority rights. As has been shown the teacher is perceived by both CAI and Non-CAI students as exercising both task-specific and nontask-specific authority rights. It has also been shown that CAI students perceived the computer as exercising task-specific rights or functions traditionally held only by the teacher. These students also appeared to see the computer as having greater task-specific power (resource capacity) and authority (legitimate exercise of power) than the teacher. Thus, compared to their Non-CAI peers, CAI students may have a more complex web of authority relations involving them in task-related activities for which the computer provides a concurrent authority system (or set of authority relations) for goal attainment. Involvement in such situations conceivably gives rise to comparison and differentiation among complex authority systems in terms of the number and types of rights, and formal and informal characteristics per holder. Thus, perception of discrepancies between the two authority systems involving teacher and computer (e.g., discrepancies in terms of task- and nontask-specific power or resource capacity) may generate differentiations between the two in terms of preference.

Scott and his colleagues (1967) theorize that, in organizational settings, the participants' authority systems may become unstable, i.e., subject to internal pressure for change, when they receive evaluations which are unsatisfactory to them. Assuming that dissatisfaction with the evaluations received implies that a participant sets for himself a level of acceptable performance evaluations, they use the term <u>incompatible</u>

to indicate unacceptable evaluations. In Scott's terminology, incompatible authority systems (i.e., authority relationships perceived to yield unacceptable evaluations) are unstable (i.e., subject to internal pressure for change).

On the basis of this theory, Scott and his colleagues are presently studying authority systems in five adult noneducational organizations. To investigate the applicability of this theory to the functioning of educational institutions,[14] data from this study were used to examine the following propositions:

1. The lower an authority's task-related power (resource capacity), the greater the incompatibility experienced in that authority system.
2. An incompatible authority system is likely to be unstable.
3. An incompatible authority system is unlikely to be preferred.
4. An unstable authority system is unlikely to be preferred.
5. An authority system in which the authority's task-related power (resource capacity) is low is unlikely to be preferred.
6. The lower an authority's task-related power (resource capacity), the greater the instability in that authority system.

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[14]This kind of structural analysis of authority systems may have only limited applicability to educational institutions, because of the special status of students in such systems. In the school, "role performance," i.e., the class work, is expected to be changed through experience in the system. Thus, in contrast to corporate or bureaucratic organizations, negative (or unsatisfactory) evaluations in education (e.g., criticism, poor grades, etc.) are a functional part of the teaching-learning process. The status of students in the educational institution also differs in that students are transitory and are in a sense "the product" of the institution as well as participating members in it.

Another consideration has to do with the effectiveness of feedback, both critical and positive, upon the learning process, and thus upon "task performance." Negative or unsatisfactory evaluations (incompatibility in Scott's sense) may be seen, at least to some degree, as desirable components of an institution designed for learning and teaching. This suggests that the measures of dissatisfaction with evaluations or grades (incompatibility) and internal pressure for change of some of the system's procedures for monitoring the students' "role performance" (instability) would be viewed quite differently through psychological concepts and theories than through sociological perspectives.

Reflection on the relative and different contributions of sociological and psychological theories to an understanding of these data might be productive. It seems possible that some of the apparently contradictory interpretations of these different viewpoints actually represent stresses within the educational institution itself. They should thus be regarded as coordinates for understanding the system rather than incompatible points of view.

Task-related power[15] or resource capacity was defined on the basis of the six questionnaire items presented in Tables 27 through 29. Three of these were part of the "expertise" cluster of items, two were part of the "trustworthiness" cluster, and one pertained to the "charisma" cluster of items. The degree to which these items were interrelated for both teacher and computer justifies their being considered as measuring a common dimension of the students' perception of these two sources of authority. For Non-CAI students, 11 (74%) of the 15 correlations among the task-related items for the teacher were significant (see Table 27). For CAI students, six (40%) of the 15 correlations among these same items were significant for the teacher and the same proportion was significant for the computer (see Tables 28 and 29). In all three instances, the proportions of significant relationships were much greater than would be expected by chance.

To provide indications of instability (i.e., internal pressure for change) in the teacher's and the computer's authority systems, three items were used. These dealt with (a) degree of satisfaction with task allocations, (b) degree of disagreement with messages transmitted, and (c) liking for performing tasks with the teacher compared to the computer (see Tables 30 through 32). That these items can be thought of as indicators of a common dimension of the students' perception of the teacher and computer authority systems is suggested by the extent to which they are interrelated (see Tables 30 through 32).

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[15] The item inquiring about the frequency with which the teacher, as compared to the computer, assigns too difficult tasks (see Table 19), was not included in the present analysis. While this item achieved significant correlations ($p < .05$) with other power items for the teacher, none were found to be significant for the computer. In fact, five of the six coefficients for the computer were negative rather than positive. This suggests that getting too difficult problems from the teacher is perceived to be a liability, but getting such problems from the computer appears to be more of a resource than a liability. This is probably because the computer, to a greater extent than the teacher, can present problems which are more often compatible with an individual student's level of achievement. This idea is supported by the fact that students report that getting problems that are too difficult occurs significantly more often with the teacher than with the computer.

TABLE 27

Intercorrelations Among Task-Related Power Items for Teacher[a]
(Non-CAI Group)

Items	1	2	3	4	5	6
1. A teacher could help you improve your math grades in one month.	1.00					
2. A teacher can answer almost all your questions.	.14	1.00				
3. How often does a teacher give you enough time to answer a question?	.34***	.32**	1.00			
4. How much information does a teacher have?	.20*	.41***	.30***	1.00		
5. I believe a teacher will always be right.	.12	.17*	.23**	.13	1.00	
6. When the teacher gives you math problems to do, how often do you understand what you are supposed to do?	.08	.29***	.36***	.28***	.23**	1.00

[a]Where appropriate, the response scale has been reversed.

* = $p < .05$
** = $p < .01$
*** = $p < .001$

The item dealing with preference for teacher, computer, textbook, or television as sources of monitoring behavior oriented toward learning mathematics may also be regarded as a measure of instability. The relationships of this item to the measures of task-related power, instability and incompatibility pertaining to teacher and computer authority systems are shown in Tables 33 through 35.

A single item was used as an indicator of incompatibility. This item dealt with the degree of satisfaction with performance evaluations by the teacher as compared to the computer. The relationships of this item to the previously mentioned measures are also shown in Tables 33 through 35.

TABLE 28

Intercorrelations Among Task-Related Power Items for Computer[a]
(CAI Group)

Items	1	2	3	4	5	6
1. A computer could help improve your math grades in one month.	1.00					
2. A computer can answer almost all your questions.	.55***	1.00				
3. How often does a computer give you enough time to answer a question?	-.06	.26	1.00			
4. How much information does a computer have?	.34*	.60***	.36*	1.00		
5. I believe a computer will always be right.	.16	.25	.27	.28	1.00	
6. When the computer gives you math problems to do, how often do you understand what you are supposed to do?	.29	.38*	.26	.21	.34*	1.00

[a]Where appropriate, the response scale has been reversed.

* = $p < .05$
** = $p < .01$
*** = $p < .001$

To examine the applicability of the propositions based on the theory of Scott and his colleagues, data from the Non-CAI group were used only for the teacher authority system, since these students did not have experience of actual interaction with the computer. Comparison between the authority systems of teacher and computer was based on data from the CAI group only.

TABLE 29

Intercorrelations Among Task-Related Power Items for Teacher[a]
(CAI Group)

Items	1	2	3	4	5	6
1. A teacher could help improve your math grades in one month.	1.00					
2. A teacher can answer almost all your questions.	.06	1.00				
3. How often does a teacher give you enough time to answer a question?	.50***	.26	1.00			
4. How much information does a teacher have?	.17	.28	.38**	1.00		
5. I believe a teacher will always be right.	.23	.58***	.40**	.47**	1.00	
6. When the teacher gives you math problems to do, how often do you understand what you are supposed to do?	.33*	.12	.28	.16	.17	1.00

[a]Where appropriate, the response scale has been reversed.

* = $p < .05$
** = $p < .01$
*** = $p < .001$

The availability of concurrent authority relations with the teacher and the computer afforded CAI students the possibility to compare and differentiate between several formal and informal aspects of these two systems. Hence, comparison between these students' views on the two systems may serve for a fuller examination of the theory.

TABLE 30

Intercorrelations Among Computer-Items Indicating Instability[a]
(CAI Group)

Items	1	2	3
1. How often do you disagree with what a computer says?	1.00		
2. Are you happy with having the computer choose which math problems to give you?	.32*	1.00	
3. Do you like doing math problems with the computer?	.39**	.39**	1.00

[a]Where appropriate, the response scale has been reversed.
$* = p < .05$
$** = p < .01$

TABLE 31

Intercorrelations Among Teacher-Items Indicating Instability
(CAI Group)

Items	1	2	3
1. How often do you disagree with what a teacher says?	1.00		
2. Are you happy with having the teacher choose which math problems to give you?	.06	1.00	
3. Do you like doing math problems with the teacher?	.04	.36*	1.00

[a]Where appropriate, the response scale has been reversed.
$* = p < .05$

TABLE 32

Intercorrelations Among Teacher-Items Indicating Instability[a]
(Non-CAI Group)

Items	1	2	3
1. How often do you disagree with what a teacher says?	1.00		
2. Are you happy with having the teacher choose which math problems to give you?	.26**	1.00	
3. Do you like doing math problems with the teacher?	.46***	.42***	1.00

[a]Where appropriate, the response scale has been reversed.
$* = p < .05$
$** = p < .01$
$*** = p < .001$

Following the propositions stated above it should be expected that for each authority system, i.e., the teacher's or the computer's, the greater the power or resource capacity attributed to the figure, the less the likelihood that the system would generate experiences of incompatibility and instability and the greater the likelihood of preference for that system. For example, with respect to the teacher authority system, the measures of power or resource capacity should be associated negatively with the measures of incompatibility and instability and positively with the measure of preference. The same pattern of relationships should be found among the measures applying to the computer authority system.

Examination of the data shown in Table 33 indicates that the pattern of relationships described above does hold for the Non-CAI students' views regarding the teacher authority system. The measures of task-related power were associated negatively with the measures of instability and incompatibility and positively with the measure of preference. Furthermore, the measure of incompatibility was associated positively with all three measures of instability and negatively with the measure of preference (see Table 33). In other words, the lower the level of task-related power attributed by Non-CAI students to their math teachers, the greater the likelihood that they would regard these teachers' evaluations as unsatisfactory (or incompatible with their own level of acceptable evaluations) and that their views about these teachers would denote instability, or a desire for change.

The data from the CAI group provide the possibility to compare these students' views about both the teacher's and the computer's authority systems. It will be recalled from the previous section, that the computer was perceived by CAI students as having greater degrees of task-specific power (resource capacity) and greater frequency of task-specific authority (legitimate exercise of power) than the teacher. As can be seen in Table 36, on all items except the one concerning time, CAI students saw the computer as having significantly greater task-related power than the teacher.

TABLE 33

Relationships Among Measures of Task-Related Power, Instability, Incompatibility, and Preference for Teacher[a] (Non-CAI Group)

Items	Instability 7	Instability 8	Instability 9	Incompatibility 10	Preference 11
Task-Related Power					
1. A teacher could help you improve your grades in one month.	-.21*	-.26**	-.07	-.07	.16
2. A teacher can answer almost all your questions.	-.18*	-.26**	-.24**	-.30***	.22**
3. How often does a teacher give you enough time to answer a question?	-.40***	-.39***	-.34***	-.42***	.11
4. How much information does a teacher have?	-.23**	-.27**	-.14	-.25**	.33***
5. I believe a teacher will always be right.	-.32***	-.28**	-.21*	-.15	.17*
6. When the teacher gives you math problems to do, how often do you understand what you are supposed to do?	-.31***	-.56***	-.31***	-.46***	.25**
Instability					
7. How often do you disagree with what a teacher says?				.38***	-.30***
8. Are you happy with having the teacher choose which math problems to give you?				.37***	-.31***
9. Do you like doing math problems with the teacher?				.47***	-.40***
Incompatibility					
10. Are you happy with the scores the teacher gives you on math problems?					-.28**
Preference					
11. I would prefer to learn math from a teacher.					

[a]Where appropriate, the response scale has been reversed.
* = p < .05
** = p < .01
*** = p < .001

TABLE 34

Relationships Among Measures of Task-Related Power, Instability, Incompatibility, and Preference for Computer[a] (CAI Group)

Items	Instability 7	Instability 8	Instability 9	Incompatibility 10	Preference 11
Task-Related Power					
1. A computer could help improve your math grades in one month.	-.53***	-.16	-.16	-.08	.41**
2. A computer can answer almost all your questions.	-.28	.00	-.43**	-.29	.45**
3. How often does a computer give you enough time to answer a question?	-.17	-.39**	-.25	-.39**	.37**
4. How much information does a computer have?	-.26	-.02	-.30*	-.33*	.42**
5. I believe a computer will always be right.	-.38**	-.34*	-.44**	-.40**	.43**
6. When the computer gives you math problems to do, how often do you understand what you are supposed to do?	-.47***	-.48***	-.28	-.17	.26
Instability					
7. How often do you disagree with what a computer says?				.28*	-.49***
8. Are you happy with having the computer choose which math problems to give you?				.17	-.31*
9. Do you like doing math problems with the computer?				.28*	-.46**
Incompatibility					
10. Are you happy with the scores the computer gives you on math problems?					-.43**
Preference					
11. I would prefer to learn math from a computer.					

[a]Where appropriate, the response scale has been reversed.
* = p < .05
** = p < .01
*** = p < .001

TABLE 35

Relationships Among Measures of Task-Related Power, Instability, Incompatibility and Preference for Teacher[a] (CAI Group)

Items	Instability 7	8	9	Incompatibility 10	Preference 11
Task-Related Power					
1. A teacher could help you improve your math grades in one month.	-.09	-.43**	-.20	-.24	.21
2. A teacher can answer almost all your questions.	-.45**	.19	-.25	-.17	.15
3. How often does a teacher give you enough time to answer a question?	-.25	-.11	-.15	-.34*	.19
4. How much information does a teacher have?	-.19	.11	-.10	-.04	.26
5. I believe a teacher will always be right.	-.26	.07	.05	.08	.07
6. When the teacher gives you math problems to do, how often do you understand what you are supposed to do?	-.18	-.26	-.10	-.47***	.16
Instability					
7. How often do you disagree with what a teacher says?				.34*	-.44***
8. Are you happy with having the teacher choose which math problems to give you?				.25	-.08
9. Do you like doing math problems with the teacher?				.30*	-.15
Incompatibility					
10. Are you happy with the scores the teacher gives you on math problems?					-.32*
Preference					
11. I would prefer to learn math from a teacher.					

[a]Where appropriate, the response scale has been reversed.
* = $p < .05$
** = $p < .01$
*** = $p < .001$

In view of these findings and the propositions above, for CAI students, the authority system of the computer should be less incompatible, less unstable, and more widely preferred than that of the teacher. Support for this prediction is found in Table 37. CAI students appeared to experience a significantly lower degree of incompatibility with the computer's than the teacher's evaluations of their performance; that is, from these students' point of view, evaluations which are unsatisfactory to them are much less likely to come from the computer than from the teacher. For CAI students there were also significant differences between teacher and computer authority systems on all three measures of instability. That is, these students appeared to experience significantly less satisfaction with the teacher's than the computer's task allocations, less liking for performing tasks with the teacher than the computer, and more frequent disagreement with the teacher's than the computer's messages. It is not surprising,

TABLE 36

Comparisons Between Teacher and Computer on Task-Related Power (Resource Capacity) Items (CAI Group)

Items	Teacher $\bar{X}$	Computer $\bar{X}$	t^a
A teacher (computer) could help you improve your math grades in one month.	2.66	2.11	2.44*
A teacher (computer) can answer almost all your questions.	2.75	2.25	2.31*
How often does a teacher (computer) give you enough time to answer a question?	1.72	2.09	-0.70
How much information does a teacher (computer) have?	2.71	3.33	-3.04**
I believe a teacher (computer) will always be right.	3.20	2.03	6.52***
When a teacher (computer) gives you math problems to do, how often do you understand what you are supposed to do?	2.15	2.68	-3.22**

[a]Two-tailed t.
* = $p < .05$
** = $p < .01$
*** = $p < .001$

then, to find that, as far as tasks related to learning mathematics are concerned, CAI students indicated a significantly greater preference for having them monitored by the computer than by the teacher.

For the CAI group, the relationships among the measures of task-related power, incompatibility, instability, and preference for computer (see Table 34) were also found to follow a pattern similar to that concerning the Non-CAI students' perception of the teacher (see Table 33). The correlational matrix pertaining to the CAI students' perception of the teacher (see Table 35) includes fewer significant coefficients, although the associations among the four categories of measures were generally in the expected direction. That is, while there is a strong tendency for the propositions derived from Scott's theory to hold among the teacher items for Non-CAI students and among the computer items for CAI students, this tendency was considerably reduced with respect to teacher items for CAI students. This was particularly true for the relationships among the measures concerning CAI students' perception of the teacher's task-related power or resource capacity, a crucial basis for organizational authority.

These data are congruent with Emerson's (1962) postulate that in a power-dependence relationship A's power over B is directly proportional to the extent that A can mediate between B and B's goals and inversely proportional to the extent that alternative (concurrent) power-dependence relations are available to B for goal attainment. Given the goal of learning mathematics and the specific tasks involved in this goal (i.e., solving math problems) it is conceivable that, for CAI students, task-specific relations with the computer may function concurrently to their relations to the teacher. This, in turn, may modify their perception of the teacher in terms of both level and legitimacy of task-related power, a critical basis for task-specific authority.

Comparisons between CAI and Non-CAI students in terms of mean scores indicating their perceptions of the teacher yielded few significant differences. On the semantic differential, CAI students, compared to their Non-CAI peers, demonstrated generally more favorable attitudes toward the teacher. However, CAI students were significantly less inclined than their Non-CAI peers to ascribe to the teacher charismatic qualities.

TABLE 37

Comparisons Between Teacher and Computer on Measures of Incompatibility, Instability, and Preference (CAI Group)

Items	Teacher $\bar{X}$	Computer $\bar{X}$	t^a
Incompatibility			
Are you happy with the scores the teacher (computer) gives you on math problems?	1.94	2.51	-3.04**
Instability			
Are you happy with having the teacher (computer) choose which math problems to give you?	1.69	2.44	-3.61***
Do you like doing math problems with the teacher (computer)?	1.81	3.00	-5.75***
How often do you disagree with what a teacher (computer) says?	2.67	1.62	5.33***
Preference			
I would prefer to learn math from a teacher (computer).	2.23	1.63	3.11**

[a]Two-tailed t.
* = $p < .05$
** = $p < .01$
*** = $p < .001$

Also, CAI students, compared to their Non-CAI peers, reported significantly less satisfaction with having math problems assigned to them and evaluated by the teacher. Of course, these data may indicate that CAI students, compared to their Non-CAI peers, had less favorable attitudes toward their teachers before they obtained experiences of CAI.[16] The finding that students interacting with CAI, compared to those who had no

[16]To clarify questions related to this problem, further analyses have been planned using data obtained from students before and after their involvement in CAI.

such experiences, tended to have a more favorable overall image of the teacher (as reflected on the data from the semantic differential) suggests that CAI students may become less dependent on the teacher's resources for goal achievement and gain a more positive sense of efficacy with respect to the teacher. Thus, experience with concurrent authority relations (with the teacher and CAI), may enhance a realistic appraisal of both authority systems and thereby facilitate a positive general and personal interaction with the teacher.

Summary and Conclusions

The findings that emerge from this initial study of the interaction between the child and CAI are relevant to several of the questions initially posed and to future research on interaction between pupils and nonhuman teachers. Analyses of the results suggest that there are several major dimensions along which this relationship may be usefully studied. One cluster of dimensions has to do with the orientation and attitudes of the student toward CAI and toward computers in general. This group includes first, feelings that the computer has charisma; second, an attractiveness that CAI and the computer have for the children in this study; third, a perception of the machine as expert which gives particular power to its role as a teacher.

A second cluster of dimensions useful for examining patterns of interaction between the child and the machine is more concerned with the relative status and roles of the machine-teacher and the child. Imbedded in an educational setting such as the school, the CAI programs together with the hardware that delivers them have an enormous authority. This is based, in part, upon the fact that the program is approved by and introduced by the school authorities and, in part, upon the acceptance of its authority role by the children themselves. In this context it may be seen as holding the power to assign tasks and to evaluate the child's performance on these tasks. This evaluation is a type of reward (positive or negative), giving the computer a capacity parallel to that of the teacher: it can assign tasks, evaluate the child's performance on these assignments, and reward him with appropriate feedback.

In the specific school where the data for this study were collected, the computer's evaluation function presumably has little to do with the children's grades. However, it is only a small step to an educational situation in which the grades themselves _are_ determined by the child's performance on CAI programs. In this sense the CAI duplicates the task-related functions of the teacher and, together with the child's attribution of charisma, expertise, and trustworthiness to CAI, constitutes an interactive system which is similar to that of the teacher-pupil relationship in many essential ways.

This does not hold for interactions that are not related to the task -- at least not in drill-and-practice programs. In interactions that have to do with attentiveness, cooperation, or other classroom behavior, the teacher and computer are seen as quite different, primarily from the fact that the computer is not seen as relevant in this area. This appears to be to the advantage of the computer and the CAI programs, as children seem to feel that evaluations of their nontask-related behavior will be carried over by teachers into evaluation (grades) of their classroom work.

This differentiation is an important one for considering the uses of CAI with children of low-income and minority populations who may feel, from time to time, that they are not completely understood by the classroom teacher and/or are treated with subtle but real discrimination, based either upon ethnic differences or upon the teacher's distaste for behavior which he finds violates his own standards. This hypothetical situation (no such evidence was found in this study) may make CAI of particular usefulness in helping certain children to learn basic skills that will make it easier for them to relate to the teacher, to their classmates, and to the material presented by the formal school curriculum.

The students in the group being studied have a very positive image of CAI and the computer -- they like it, they think it gives the right answers and has a vast array of information available to it. They see it as fair, they trust its evaluation as well as its handling of the task assignments, and sometimes attribute to it an almost human role. The CAI network differs from other mass media to which they are accustomed in that it appears to originate its own message in interaction. Radio, television, movies -- all these involve representations and reproductions of people, sounds, and visual stimuli originated in another place and transmitted through the media. CAI on the other hand appears to, and in a sense does, originate the message in interaction with the child's performance. In that sense the communication and interaction between them is an original transcript.

It is perhaps this aspect of the interaction that may lend some of the charisma and human-like qualities to the machine. It is aided, no doubt, by the tendency of programmers to introduce humanizing statements such as greetings, goodbyes, etc.

The image the students hold of the computer and CAI apparently draw from a much more general image in the population rather than specifically from their experience with the program. Students in the research group who had no experience in CAI had levels of positive regard for the computer similar to those with CAI experience. This seems reasonable in view of the images projected about computers in the mass media and in movies such as 2001: A Space Odyssey, and the use of reference to computers in advertising to create an aura of expertise and superhuman efficiency. The impact of the experience with CAI was more specifically on those things that had to do with the use of the computer in an educational setting -- that is, with the math drill-and-practice program itself.

CAI and the computer are seen in relatively positive terms in comparison with other sources of information and instruction. There is a great deal of similarity between the teacher and CAI in areas that have to do directly with instruction in math. The teacher suffers somewhat in the comparison, however, probably because of his role in nontask-related activities such as study habits, pressure to attend to work and to complete tasks, and in the general application of discipline. The computer is assigned for only a short period during the day and does not get involved in these other interactions with students. Just as the teacher sometimes evaluates the performance of students on the basis of behavior not related to math, so the students tend to confound the disciplinary aspects of the teacher's role with his fairness and efficiency in the instructional areas.

There may be other features of CAI which contribute to its attractiveness as a teacher. It appears from observations and from the work reported here that the student's engagement with CAI is maintained over a period of time that far exceeds his interest in gadgetry and his accommodation to the technical equipment itself. This level of interest and engagement is, the investigators believe, related to the pacing of the CAI presentation of content itself. That is, the CAI lessons present to the child a challenge to his competence which is sufficiently close to but slightly above his actual level. The CAI program acts as if it always presented a question to the child: "You have been able to do those problems; now can you do this one?" In this sense the interaction between the student and machine is always producing new information -- an affirmation of the student's competence on a particular task.

The investigators suggest that a situation which tests one's competence [illegible]st some external standard is highly motivating; it also ordinarily requires great individualization of presentation. CAI is particularly adapted to this kind of interaction. This may account for the positive attitudes of pupils toward CAI. This hypothesis is being examined in greater detail in an experiment now being conducted by a member of the research team and will be reported subsequently in a Research and Development Memorandum.

The implications of the study fall into three general areas: Instruction and curriculum, application to noneducational settings, and research.

1. One implication of the findings is that the machine is seen primarily in terms of task-related functions and does not bring with it the affective and evaluative components that teachers inevitably carry in their relationships with students. Therefore, it may have particular usefulness in teaching children who usually think of themselves as an object of discrimination or prejudice. For them the neutrality of CAI as a teacher, the lack of residue or carryover of the prejudice of past failures, the feeling that the grades and evaluations they get are what they have earned, offer a more effective learning situation.

2. The findings also have implications for the use of educational technology in teaching attitudes and other value-oriented learnings -- interpretations of history, social studies, civics, and the like. While the expertise, fairness, and neutrality of the machine make it a natural instrument for teaching in the specifically skill-oriented subjects -- arithmetic, reading, spelling, science, etc., it can also be used to teach material which is more value-laden and eventually will probably be used in this way. It will be of great interest (to the researcher at least) to see the degree to which the machine as a source of interpretations and values will be accepted by students.

3. The high level of trust that students have in the computer when they encounter it in an educational setting suggests that these attitudes may be transferred to interaction with machines in other settings. While there is no compelling reason to believe that credibility of the consumer in relation to technology is likely to lead to deceit and attempts to mislead, the educational experience would appear to socialize the child into attitudes of compliance and confidence in interaction with computer-like machines. There is also no obvious reason why machines could not be used to promote fraud, or to confuse and misinform the consumer. In any case, this experience in the school may tend to establish patterns of interaction between the individual and a technological society.

4. The possibility of transfer of attitudes from CAI in school to exchanges with computers in noneducational contexts suggests several lines of research. One of these might look into efforts to alter the awe the child develops for computer sources of information. Another could consider the possibility that children from low-income, less-well-educated parents and low-status parts of the society may overestimate the power of the computer and tend to exhibit greater credulity than children from middle-class backgrounds. There is some empirical evidence to think this may be true.

5. Another research possibility the findings offer is the analysis of teacher behavior and teaching processes by permitting a differentiation between those things which are task-related and those teacher behaviors which are auxiliary to the instructional function. This may also permit

some differentiation of affective and instructional elements in teaching and enable the researcher to plan experimental examination of their relative effects in the teaching process.

6. Another implication of the findings is that they may offer suggestions about ways to prepare the teacher to deal more effectively with CAI and with the threat that it poses to some members of the profession. The types of analysis already done, and that may be done as an extension of this work, will give the teacher a more explicit perspective of what the computer can do and what it cannot do. This will make possible a training program which is based on realistic appraisal of the teacher's most effective resources in collaboration or competition with the machine and provide a basis for developing his own teaching resources.

7. The type of analysis described here permits a more exhaustive study of the features of the computer and CAI and an examination of the elements which are particularly engaging to the child. In essence, this is a study of the properties of the machine, of the program, and of the auxiliary reinforcing strategies the machine programs employ. Of particular interest is the degree of intrinsic incentive inherent in a properly designed program and the usefulness of externally applied reinforcing signals through verbal or other channels.

In summary, it seems that a view of the computer as a dispenser of information is simplistic and distorted. It fails to indicate the extent to which CAI involves the student in interaction which has affective and social overtones in addition to its instructional function. This interaction, and the ways in which it might be varied in future programs, have potential effects not only upon <u>what</u> a child learns but also upon the processes through which he relates himself to the structures, both technological and human, of a complex society.

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APPENDIX 1

(NOTE: The numbering of the items in this appendix reflects the data coding system. No items have been omitted.)

YOUR IDEAS ABOUT PEOPLE AND COMPUTERS

In this booklet there are some questions about the sorts of things students do at school and at home. Students have many different ideas about these things. We want to know what you think; we want your ideas.

This is not a school test. No one at school or at home will see what you put down.

Be sure to answer every question. There will be different kinds of questions and answers. As we go along, we will explain to you how you can show us what your idea is about each question.

Before you turn the page, print your name and your grade in the school. Please use capital letters.

NAME: ____

GRADE: ______________________

Here are some questions about things that may happen to a student at school and at home. We want to know how often they happen to you. For example:

How often do your parents tell you what to do?

Your answer may be:

Usually, Sometimes, Almost never, Don't know

3 2 1 9

We will ask the same question for parents, math teacher, and computer. We want your answer on each of the three sentences. Choose one answer for each, and circle the number under it. If you want to change your answer, make a wavy line through the circled number which you want to change and circle the new number.

		Usually	Sometimes	Almost never	Don't know
(121)	The math teacher shows interest in the math work you do	3	2	1	9
(122)	The computer shows interest in the math work you do	3	2	1	9
(123)	Your parents show interest in the math work you do	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(124)	The math teacher punishes you when you do something wrong	3	2	1	9
(125)	The computer punishes you when you do something wrong	3	2	1	9
(126)	Your parents punish you when you do something wrong	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(127)	The math teacher chooses which math problems to give you	3	2	1	9
(128)	The computer chooses which math problems to give you	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(129)	The math teacher shows you how well or how poorly you are doing in math problems	3	2	1	9
(130)	The computer shows you how well or how poorly you are doing in math problems	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(131)	The math teacher helps you learn to do math problems	3	2	1	9
(132)	The computer helps you learn to do math problems	3	2	1	9
(133)	Your parents help you learn to do math problems	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(134)	The math teacher gets impatient with you	3	2	1	9
(135)	The computer gets impatient with you	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(136)	The math teacher helps you get better math grades	3	2	1	9
(137)	The computer helps you get better math grades	3	2	1	9
(138)	Your parents help you get better math grades	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(139)	The math teacher checks your math problems	3	2	1	9
(140)	The computer checks your math problems	3	2	1	9
(141)	Your parents check your math problems	3	2	1	9

		Usually	Sometimes	Almost never	Don't know
(142)	The math teacher corrects your behavior	3	2	1	9
(143)	The computer corrects your behavior	3	2	1	9
(144)	Your parents correct your behavior	3	2	1	9

The purpose of the next five pages is to find out what some words mean to you. On each page there is a different word. The word at the top of the first page is FRIEND. On each line under FRIEND there are two words, one on each side of it. There are five blank spaces between the words. The words are: "hard-soft," "fast-slow," and so on. As you see, these words are opposites - hard is the opposite of soft, fast is the opposite of slow. Now think about the word FRIEND. If you think a friend is "hard," then put an X in the space next to "hard." If, on the other hand, you feel that a friend is "soft," then put an X next to "soft." Suppose you would choose the word hard but not too hard. Then you will put your X in the second space from "hard." Or, if you think that you would choose the word soft but not too soft then put your X in the second space from "soft." If you cannot make up your mind, put your X in the middle space. Now, remember, there are no right or wrong answers. Don't spend more than a couple of seconds on each line. Put your X in one of the spaces between the dots. Let's practice on the rest of the words under FRIEND.

EXAMPLE:

FRIEND

hard	_____:_____:_____:_____:_____	soft
fast	_____:_____:_____:_____:_____	slow
gives right answers	_____:_____:_____:_____:_____	gives wrong answers
fair	_____:_____:_____:_____:_____	unfair
bad	_____:_____:_____:_____:_____	good
cold	_____:_____:_____:_____:_____	warm
like	_____:_____:_____:_____:_____	dislike
confusing	_____:_____:_____:_____:_____	clear
big	_____:_____:_____:_____:_____	small
difficult	_____:_____:_____:_____:_____	easy

TEACHER

(145) hard _____:_____:_____:_____:_____ soft

(146) fast _____:_____:_____:_____:_____ slow

(147) gives right answers _____:_____:_____:_____:_____ gives wrong answers

(148) fair _____:_____:_____:_____:_____ unfair

(149) bad _____:_____:_____:_____:_____ good

(150) cold _____:_____:_____:_____:_____ warm

(151) like _____:_____:_____:_____:_____ dislike

(152) confusing _____:_____:_____:_____:_____ clear

(153) big _____:_____:_____:_____:_____ small

(154) difficult _____:_____:_____:_____:_____ easy

COMPUTER

(155)	hard	____:____:____:____:____	soft
(156)	fast	____:____:____:____:____	slow
(157)	gives right answers	____:____:____:____:____	gives wrong answers
(158)	fair	____:____:____:____:____	unfair
(159)	bad	____:____:____:____:____	good
(160)	cold	____:____:____:____:____	warm
(161)	like	____:____:____:____:____	dislike
(162)	confusing	____:____:____:____:____	clear
(163)	big	____:____:____:____:____	small
(164)	difficult	____:____:____:____:____	easy

T.V. NEWS

(165)	hard	____:____:____:____:____	soft
(166)	fast	____:____:____:____:____	slow
(167)	gives right answers	____:____:____:____:____	gives wrong answers
(168)	fair	____:____:____:____:____	unfair
(169)	bad	____:____:____:____:____	good
(170)	cold	____:____:____:____:____	warm
(171)	like	____:____:____:____:____	dislike
(172)	confusing	____:____:____:____:____	clear
(173)	big	____:____:____:____:____	small
(174)	difficult	____:____:____:____:____	easy

TEXTBOOK

(221) hard_____:_____:_____:_____:_____ soft

(222) fast_____:_____:_____:_____:_____ slow

(223) gives right answers_____:_____:_____:_____:_____ gives wrong answers

(224) fair_____:_____:_____:_____:_____ unfair

(225) bad_____:_____:_____:_____:_____ good

(226) cold_____:_____:_____:_____:_____ warm

(227) like_____:_____:_____:_____:_____ dislike

(228) confusing_____:_____:_____:_____:_____ clear

(229) big_____:_____:_____:_____:_____ small

(230) difficult_____:_____:_____:_____:_____ easy

Now you will find sentences like this:

Playing games is usually fun.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

The responses to this sentence go from "strongly disagree" to "strongly agree." Choose the response that comes closest to your idea and circle the number below it. If you cannot decide, circle the number under "don't know." Answer the following questions in the same way.

(231) Most students think that computers are hard to work with.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(232) The idea of using a computer scares me.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(233) Most big machines are really run by computers.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(234) Most of my friends don't trust teachers.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(235) Most of my friends don't trust computers.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(236) Most of my friends don't trust T.V. news.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(237) A teacher could help you improve your math grades in one month.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(238) A computer could help you improve your math grades in one month.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(239) A teacher can answer almost all your questions.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(240) A computer can answer almost all your questions.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(241) Computers are smarter than people.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

(242) Computers are smarter than textbooks.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(243) A computer sometimes acts like a person.

Strongly disagree	Disagree	Agree	Strongly agree	Don't know
4	3	2	1	9

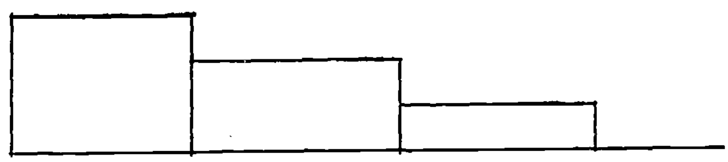
(244) A teacher never gets tired of working with you.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(245) A computer never gets tired of working with you.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

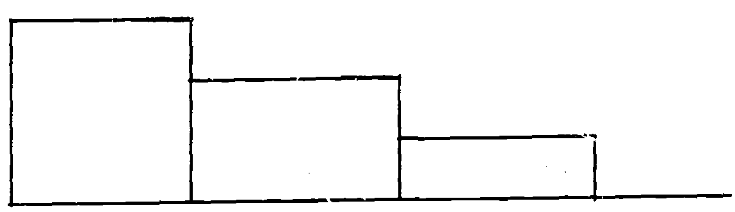
Another kind of question you will find is like this:
How often do you play games?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

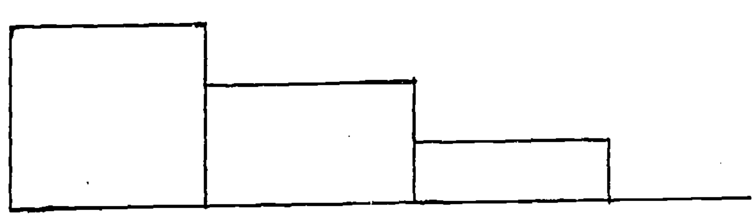
The responses here go from "always" to "never." Choose the response that comes closest to your idea and circle the number below it.

(246) How often do you know what a teacher is going to do next?



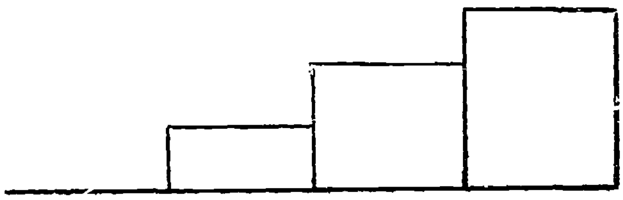
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(247) How often do you know what a computer is going to do next?



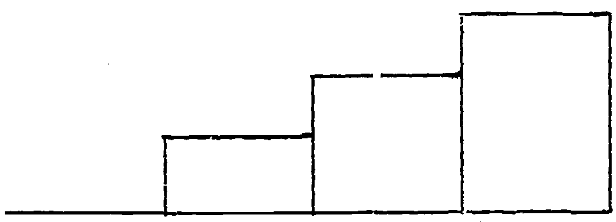
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(248) How often does a teacher give you enough time to answer a question?



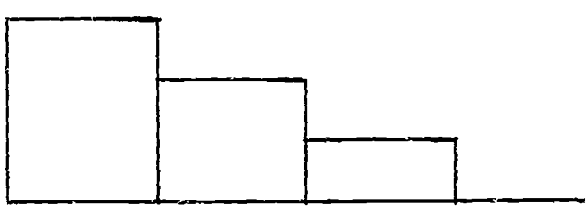
Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

(249) How often does a computer give you enough time to answer a question?



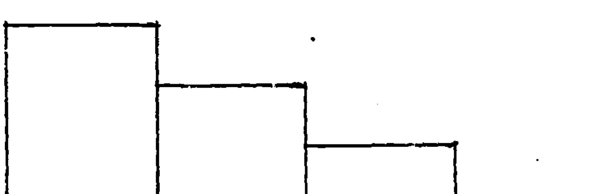
Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

(250) How often do you disagree with what a teacher says?



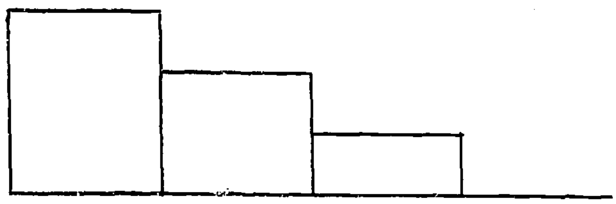
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(251) How often do you disagree with what a computer says?



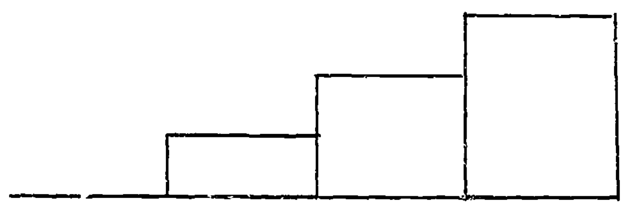
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(252) How often do you disagree with what a T.V. news says?



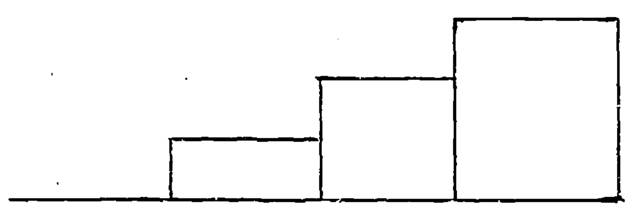
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(253) How much information does a teacher have?
(Circle the number under one answer only)



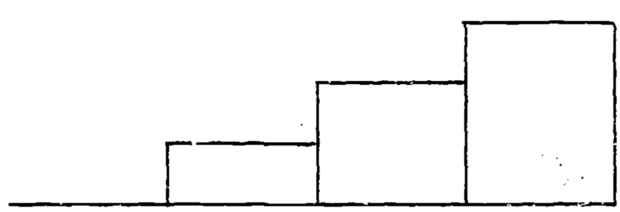
None	Some	Much	Very much	Don't know
1	2	3	4	9

(254) How much information does a computer have?



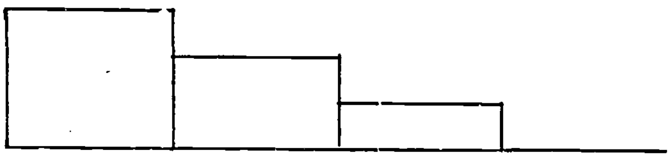
None	Some	Much	Very much	Don't know
1	2	3	4	9

(255) How much information does T.V. news have?



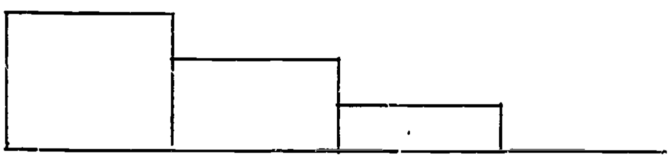
None	Some	Much	Very much	Don't know
1	2	3	4	9

(256) If you wanted to change something in a teacher's lesson do you think you could change it?



Yes, always	Yes usually	Yes sometimes	No, never	Don't know
4	3	2	1	9

(257) If you wanted to change something in a computer's lesson do you think you could change it?



Yes, always	Yes usually	Yes sometimes	No, never	Don't know
4	3	2	1	9

Which one decides what math lessons you get from the computer?

(Circle the number under "Yes," "No," or "Don't know" for each answer)

		Yes	No	Don't know
(258)	The math teacher decides	2	1	9
		Yes	No	Don't know
(259)	Somebody at Stanford decides	2	1	9
		Yes	No	Don't know
(260)	The score I got the day before decides	2	1	9
		Yes	No	Don't know
(261)	The computer supervisor decides	2	1	9
		Yes	No	Don't know
(262)	The computer decides	2	1	9

(263) I believe a teacher will always be right.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

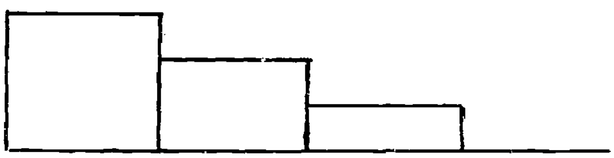
(264) I believe a computer will always be right.

Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(265) I believe a T.V. news will always be right.

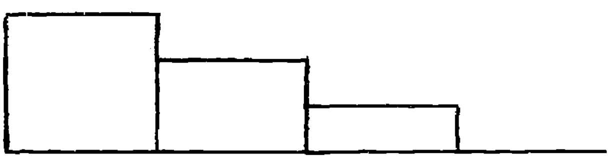
Strongly agree	Agree	Disagree	Strongly disagree	Don't know
1	2	3	4	9

(266) When the teacher gives you math problems to do, how often do you understand what you are supposed to do?



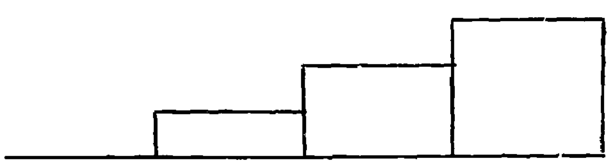
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(267) When the computer gives you math problems to do, how often do you understand what you are supposed to do?



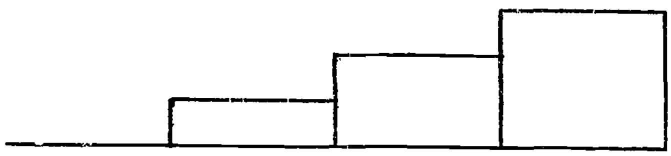
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(268) How often does the teacher give you math problems which are too hard?



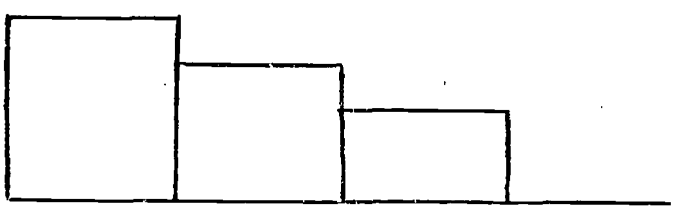
Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

(269) How often does the computer give you math problems which are too hard?



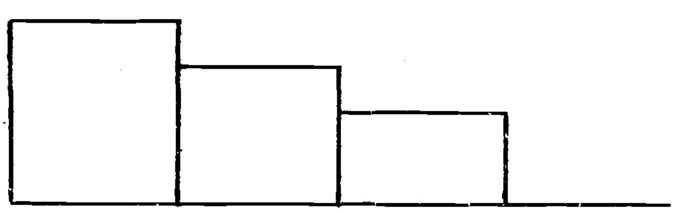
Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

(270) Are you happy with having the teacher choose which math problems to give you?



Yes, very much	Yes, much	Yes, some	No, not at all	Don't know
4	3	2	1	9

(271) Are you happy with having the computer choose which math problems to give you?



Yes, very much	Yes, much	Yes, some	No, not at all	Don't know
4	3	2	1	9

What can happen to students who do a poor job on math problems given by the teacher?
(Circle the number under "Yes," "No," or "Don't know" for each answer)

		Yes	No	Don't know
(272)	They get poor grades	2	1	9
(273)	The teacher frowns at them	2	1	9
(274)	The teacher won't like them	2	1	9
(275)	They have to stay after school	2	1	9

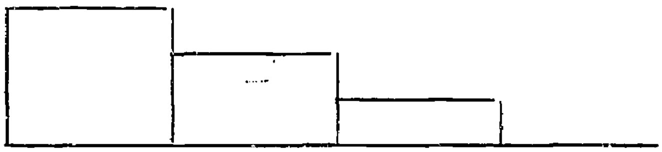
What can happen to students who do a poor job on math problems given by the computer?

		Yes	No	Don't know
(321)	They get poor grades	2	1	9
(322)	The teacher frowns at them	2	1	9
(323)	The teacher won't like them	2	1	9
(324)	They have to stay after school	2	1	9

How bad is this?
(Circle the number under one answer only for each line)

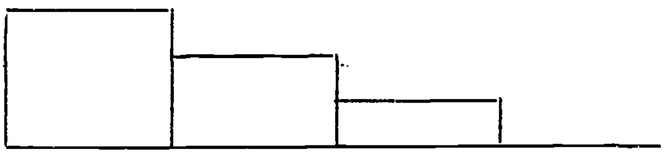
		Not bad at all	Not very bad	Bad	Very bad	Don't know
(325)	Getting poor grades	1	2	3	4	9
(326)	Getting frowns from the teacher	1	2	3	4	9
(327)	Not being liked by the teacher	1	2	3	4	9
(328)	Having to stay after school	1	2	3	4	9

(329) When you have done a math problem, does the teacher tell you if you are right or wrong?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(330) When you have done a math problem, does the computer tell you if you are right or wrong?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

What do you care about on the math problems you do?

		Yes, much	Yes, some	Yes, a little	No, not at all	Don't know
(331)	How fast I do math problems	4	3	2	1	9
(332)	If I get them right	4	3	2	1	9
(333)	If I get them all done	4	3	2	1	9
(334)	Having a neat paper	4	3	2	1	9
(335)	Other things such as coming in late, being absent, talking too much	4	3	2	1	9

What does the math teacher care about on the math problems you do? (Circle the number under one answer only for each line)

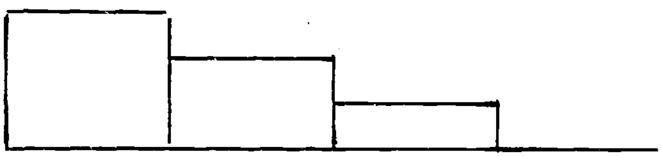
		Yes, much	Yes, some	Yes, a little	No, not at all	Don't know
(336)	How fast I do math problems	4	3	2	1	9
(337)	If I get them right	4	3	2	1	9
(338)	If I get them all done	4	3	2	1	9

		Yes, much	Yes, some	Yes, a little	No, not at all	Don't know
(339)	Having a neat paper	4	3	2	1	9
(340)	Other things, such as coming in late, being absent, talking too much.	4	3	2	1	9

What does the computer care about?
(Circle the number under one answer only for each line.)

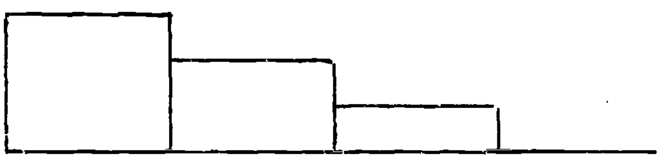
		Yes, much	Yes, some	Yes, a little	No, not at all	Don't know
(341)	How fast I do math problems	4	3	2	1	9
(342)	If I get them right	4	3	2	1	9
(343)	If I get them all done	4	3	2	1	9
(344)	Having a neat paper	4	3	2	1	9
(345)	Other things, such as coming in late, being absent, talking too much.	4	3	2	1	9

(346) Do you think that the scores you get on math problems from the teacher change your math grade?



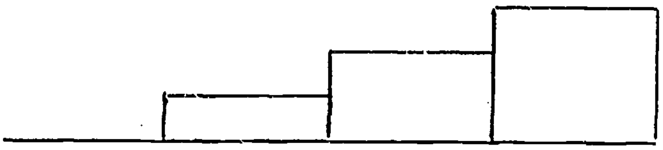
Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(347) Do you think that the scores you get on math problems from the computer change your math grade?



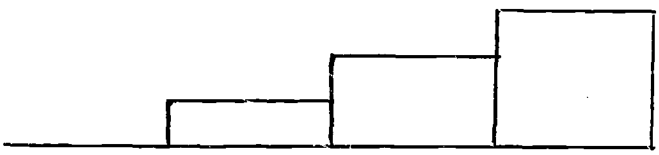
Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(348) How much do you care about the scores the teacher gives you on math problems you do?



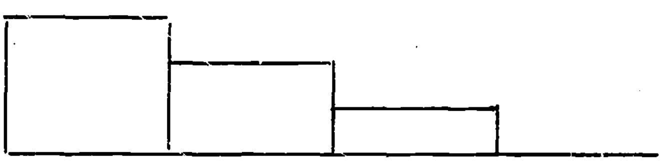
Not at all	A little	Much	Very much	Don't know
1	2	3	4	9

(349) How much do you care about the scores the computer gives you on math problems you do?



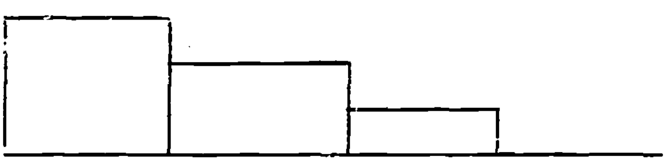
Not at all	A little	Much	Very much	Don't know
1	2	3	4	9

(350) Are you happy with the scores the teacher gives you on math problems?



Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(351) Are you happy with the scores the computer gives you on math problems?



Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(352) If you could choose, would the computer score more, the same or less of your math problems?

More	The same	Less	Don't know
3	2	1	9

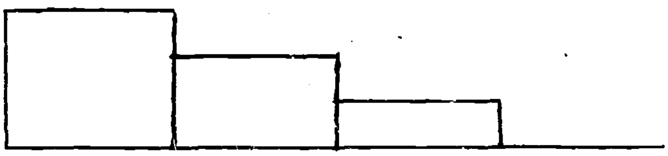
(353) If your math teacher could choose, would the computer score more, the same or less of your math problems?

More	The same	Less	Don't know
3	2	1	9

(354) If your friends could choose, would the computer score more, the same or less of their math problems?

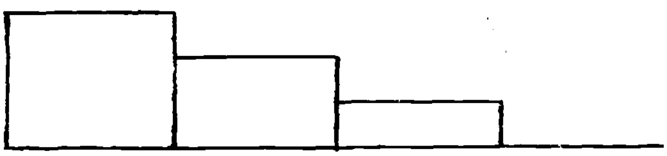
More	The same	Less	Don't know
3	2	1	9

(355) Do you like doing math problems with the math teacher?



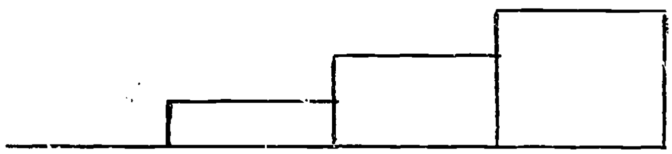
Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(356) Do you like doing math problems with the computer? (Or do you think you would like it?)



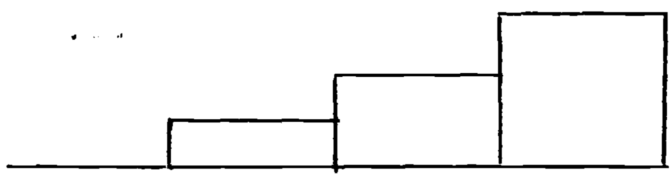
Yes, very much	Yes, much	Yes, a little	No, not at all	Don't know
4	3	2	1	9

(357) How often does a computer break down?



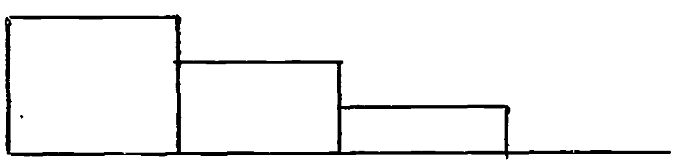
Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

(358) How often does a T.V. set break down?



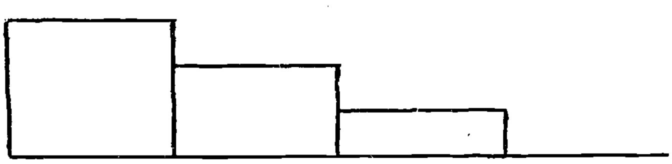
Never	Sometimes	Usually	Always	Don't know
1	2	3	4	9

(359) How often does a teacher make a mistake?



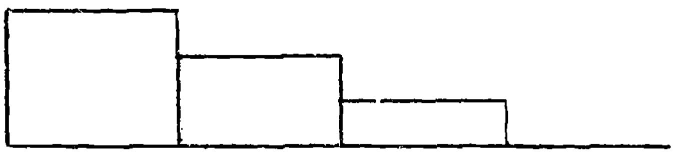
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(360) How often does a computer make a mistake?



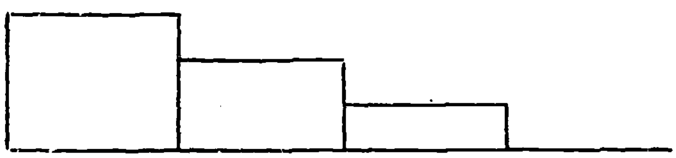
Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(361) How often does the T.V. news make a mistake?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

(362) How often does a textbook make a mistake?



Always	Usually	Sometimes	Never	Don't know
4	3	2	1	9

I would prefer to learn math from a

(363) teacher____ (364) computer____ (365) T.V.____ (366) textbook____

Put a 1 next to your first choice, 2 for your second choice, 3 for your third choice, and 4 for your last choice.

APPENDIX 2

INTERVIEW

PART A (For CAI and Non-CAI students)

Have you ever seen a computer?

Where? Heard about?

Tell me about it. (Look like? Do?)

Where do you think it gets its information?

How?

What kinds of things can a computer do?

__ other programs besides math?

__ outside of school?

Is that a computer in the room by the office?

What do you think about computers in schools?

Who works on the computer here?

__ Who chooses them?

__ If you weren't chosen, could you ask to be on it?

What do you think your teacher/principal feels about having a computer here?

How do you learn arithmetic?

How do you know how well you do?	Class/computer
Do you have tests?	Class/computer
How are you graded?	Class/computer
Do the grades go on your report card?	Class/computer

(The next three questions compare: 1) class/computer, and 2) graded/not graded.)

Which way do you work harder? (Do you think you would.....?)

Which way do you learn more?

Which way do you like better?

Which do you think gives you the most fair grades -- teacher or computer?

Are there differences between the way your teacher and the computer give directions?

Seems to me people/you must have a different feeling when they/you sit at that computer?

What do you think? (Fun? Charisma?)

Which knows more: teacher or computer?

Does computer/teacher make mistakes? What kind?

How does computer/teacher get his knowledge?

What kind of things does computer/teacher know?

Do you think computers could help with other things besides arithmetic? (What things?)

If you could choose teacher or computer for arithmetic, which would you choose to work with most of the time? (Why?)

Suppose you have a problem, not an arithmetic one, where would you go for help?

Give me an example.

PART B (Only for CAI students)

How did you feel the first time you sat down at the machine?

A month later? Now?

- How did you happen to get on the program?
- What do you do?
- How does the program end? (Oh, it calls you by name; what name might you call it if you were to say goodbye?)
- How about the speed of the computer? (fast-slow)
- Do you find it hard? (easy?)
- How much time do you spend on the computer? (Would like to spend---why?)
- How does working at the computer compare with classwork? (easier, faster, interesting?)
- How does the computer get the problems for you?

- -- Does everybody get the same one?
- -- What do you think about that, that it gives certain problems just for you?
- -- Since you've been on the computer, do you think there's any change in your arithmetic? (How do you think the computer helped you? Why not?)
- -- What do you think about knowing right away if each problem is right or wrong?

<u>I remember doing a whole page of arithmetic problems and making the same silly mistake on all the problems and having them all wrong.</u>

Have you ever done that? Do you think that would happen with a computer?

Why not? How does this help you?

<u>Is there any difference between the way you get directions from the teacher and the computer</u>?

How? Which do you prefer?

<u>You know I'm going to school and sometimes in class I look out the window and daydream</u>.

Do you ever do that? What about when you're on the computer?

(Why not?)

APPENDIX 3

Excerpts of Computer Printout of a CAI Drill-and-Practice Lesson

```
HI

PLEASE TYPE YOUR NUMBER AND NAME.
4 GEORGE WASHINGTON

HERE IS ANOTHER LESSON FOR YOU
     DRILL NUMBER L402013

 SUBTRACT

17 - 3__ = 15
NO, TRY AGAIN

17 - ___ = 15
TIME IS UP, ANSWER IS 2, TRY AGAIN

17 - _2_ = 15


___ - 10 = 10
TIME IS UP, TRY AGAIN

0__ - 10 = 10
NO, ANSWER IS 20, TRY AGAIN

20_ - 10 = 10


  3 6
-_2_8
    8


  3 8
-_1_9
 2  9
NO, TRY AGAIN

  3 8
-_1_9
 1  9


  1 5
-___7
    8

        END OF DRILL NUMBER L402013
```



```
26 FEB 70
10 PROBLEMS, 6 CORRECT IN 148 SECS. WITH 60PCT CORRECT


GOODBYE  GEORGE, PLEASE TEAR OFF ON THE DOTTED LINE
```